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AMERICAN FIELD SERVICE FELLOWSHIPS FOR FRENCH UNIVERSITIES

A limited number of fellowships for advanced study in France will be awarded for the year 1927–28. Each will carry a stipend of $1200 and will be tenable for one year, with possibility of renewal for a second year if circumstances are favorable. The fellowships are offered in a number of fields of study, including chemistry.

At present the fellowships are open only to men. A candidate

(*a*) Must be a citizen of the United States or of one of the United States' possessions.

(*b*) Must *at the time of making the application* be a graduate of a college of recognized standing or of a professional school requiring three years of study for a degree; or if not qualified in either of these ways, must be twenty-four years of age and must have spent five years in work requiring high technical skill.

(*c*) Must be of good moral character and intellectual ability, and of suitable personal qualities.

(*d*) Must have a practical ability to use French books, both in general subjects and in his own special field.

In the absence of an absolute rule as to age, preference will in all cases be given to candidates between the ages of twenty and thirty years.

Applications must be received at the office of the Executive Secretary not later than January 1, 1927.

Full information and application blanks may be obtained from the Executive Secretary, Stephen P. Duggan, Ph.D., Institute of International Education, 522 Fifth Avenue, New York, N. Y.

FELLOWSHIPS FOR GERMAN UNIVERSITIES

The American German Student Exchange, Inc., announces that a limited number of fellowships for study in Germany will be awarded to American students for the year 1927–28.

To meet the requirements for eligibility, a candidate must present proof of

(*a*) American citizenship.

(*b*) A working knowledge of German.

(*c*) Ability to carry on work at a German university, which implies at least two years in an American college or university.

(*d*) Ability to pursue independent study and research.

(*e*) Good moral character and adaptability.

(*f*) Good health.

Preference in selection will be given to applicants between the ages of twenty and thirty and particularly to those who are potential leaders in public life.

The fellowships are offered in various fields of study, including natural sciences.

The fellowships cover tuition, board, and lodging during the academic term, and are tenable for one year. Students will be expected to furnish an amount of money sufficient for traveling expenses to and from the German university and for use during periods of vacation.

American Fellows will be required to report at the universities to which they are assigned at the time of official opening (about October 15th) and to reside in Germany at least ten months.

Application blanks, properly filled out and accompanied by all required credentials, must be in the hands of the Exchange by February 15, 1927.

For application blanks and full information, address: Carl J. Friedrich, American German Student Exchange, Inc., Institute of International Education, 522 Fifth Avenue, New York.

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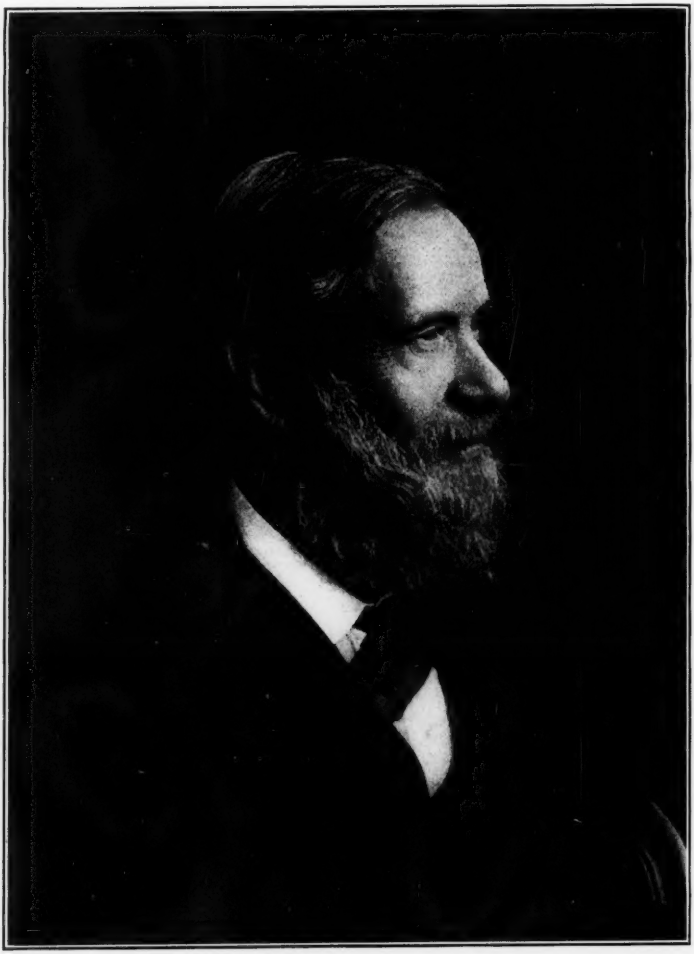


STANISLAO CANNIZZARO

EDITOR'S OUTLOOK

THIS year marks the centenary of the birth of one of the founders of modern chemical science. His portrait, lent us through the kindness of Dr. Newell, is reproduced on the opposite page.

Cannizzaro Centenary

Students, generally, are not familiar with the part which Cannizzaro played in straightening out the confusion that existed concerning atomic and equivalent weights. In this connection he performed a service which is highly essential to the development of science but which frequently fails of the appreciation it deserves—that of consolidating and organizing outpost positions already won into permanent and integral units of the general advance.

Two other points impress one on reading the biographical sketch which Dr. Newell contributes to this number; firstly, the comparatively early age at which Cannizzaro's productive career began, and, secondly, his refusal to be daunted by hostile authority. Like many another creative thinker, he lived to see the heresies advanced in his youth take their place among the unquestioned orthodoxies.

HANDICAPPED as it has been by the necessity for defending itself against prolonged litigation, the Chemical Foundation has nevertheless already accomplished a great deal toward the advancement of chemistry in America. With this drain upon its funds and energies terminated by the recent unanimous decision of the United States Supreme Court in support of the former decisions of lower courts, it can direct its undivided attention to the task which it has always considered its prime objective.

Dr. Herty Joins the Chemical Foundation

We do not know what the plans of the Foundation may be nor whether a course of action has been definitely outlined as yet, but it is apparent that no grass is to be allowed to spring up underfoot. Indicative of this fact is the announcement that Dr. Charles H. Herty, President of the Synthetic Organic Chemical Manufacturers' Association since its organization five years ago, has resigned from that office to devote his full time to the work of Advisor to the Chemical Foundation.

Dr. Herty feels that the organization which he is leaving has now firmly established itself and needs but to carry on. The Association, keenly as it regrets this parting, concurs with Dr. Herty in the opinion that he is entering upon a larger task.

We join with Dr. Herty's former associates and with his friends and

admirers throughout the country in extending the very best wishes for great success in his new work. We are, moreover, confident that these wishes will not fail of fulfilment.

The Coal Conference

THE present age is distinguished from all others in its unprecedented utilization of power, and it is apparent that this distinction will be intensified as time goes on. Already we are forced to take cognizance of the fact that our stores of natural fuel are well upon the road to eventual exhaustion.

Water power is relieving some of the drain upon our fuel resources but it is in many localities still unable to compete economically with the more efficient type of coal-burning plants by reason of its comparatively high installation costs. Engineers inform us, furthermore, that, in the United States at least, the harnessing of all available water power would not suffice to supply present demands. The utilization of geothermal power is now an actuality, yet in the light of our present knowledge its exploitation appears possible only within certain limited geographical areas. Recent developments looking toward the harnessing of tidal power are encouraging but they cannot be said to have passed the experimental stage.

Even supposing that from such sources as these all stationary power needs could be met and all railroads electrified, the problem of supplying such transitory power plants as automobiles and ships would still remain. In the meantime, therefore, it behooves us to make use of our fuel resources as economically and as efficiently as possible. All the more so since it seems likely that most of these fuels will in time assume an importance as chemical raw materials which will overbalance their significance as sources of energy.

Latest estimates of the petroleum supply, based upon more thorough geological surveys and more efficient methods of extraction, are somewhat more optimistic than earlier ones and it seems that we may confidently count upon shale oils as a future supplement. Bituminous coal, however, far surpasses both petroleum and anthracite coal in distribution and in quantity and will eventually be called upon to share the burden now borne by them. The recent Conference on Bituminous Coal at Philadelphia was, therefore, an event of interest to scientists and laymen alike.

Europe has already felt the pressure of necessity and has advanced farther in the field of soft-coal transformation than we have. The processes most familiar to American students are probably those of Bergius, Fischer, and Partart. These and a number of other foreign

experts were present at the conference and took part in discussions (soon to be published) covering the entire field of soft-coal conversion.

An important secondary consideration in connection with the more efficient utilization of coal is the fact that it appears to offer the most favorable approach to the smoke nuisance problem. Aside from the destructive effects of filth deposited by smoke, there is its detrimental influence on public health. We are just beginning to realize how important a rôle the partial exclusion of sunlight may play in various disorders of the human organism. May scientific progress and economic pressure hasten the day when this cloud shall disappear from the sky.

The Geneva Protocol

IF ONE were to search for an example in support of the contention that some knowledge of scientific facts and an adherence to the scientific attitude would be conducive to a more intelligent handling of public affairs one need go no farther than the Geneva Protocol which is to come before the present session of Congress for ratification or rejection.

Perhaps common sense alone should indicate the futility of an attempt to "outlaw" chemical warfare. If it be at all possible to abolish any single type of warfare, why not make a clean sweep and abolish *all* warfare? But, to stop at chemical warfare, does any but the fatuous optimist believe that, in the heat of international struggle, a previous agreement between nations could have the effect of repealing the ancient law of self-preservation which calls for the employment of every available means of offense and defense?

Furthermore, is there not something inescapably humorous in a discussion of the relative degree of humanity of the various methods of accomplishing wholesale murder? The gross brutality of the end in view so deeply overshadows the minor consideration of means to be employed.

However, let us pass on to an examination of the actual facts in the case. Is murder by gas more foul than murder by bullet, shell, or bayonet? We have previously mentioned in these columns the official report of the Surgeon-General of the Army for 1920. The statistics presented therein bear directly upon the question.

One is immediately struck by the fact that the use of gas so seldom results in murder outright. Naturally enough, the figures for causes of death on the field of battle are somewhat less than exact, yet we can reasonably assume that they fall within the proper degree of magnitude. We find, then, that immediate deaths due to gas are estimated at 200, whereas it is a matter of record that 70,552 casualties suffering from gas were admitted to hospitals. This may be compared with 34,049 deaths

on the battlefield and 153,537 casualties admitted to hospitals due to weapons other than gas. Curiously enough this constitutes a point in favor of gas both from the standpoint of the military strategist and that of the humanitarian. From the military point of view a casualty whom your enemy must transport to one of his hospitals and care for is worth considerably more than one who may be buried and forgotten. To the humanitarian, a man not yet dead is (theoretically, at least) one with a chance for recovery.

So far the advantage is decidedly with gas. What became of the casualties? Of those wounded by weapons other than gas over 8 per cent died, bringing the total deaths for such casualties to more than 24 per cent. Of the victims of gas, less than 2 per cent died, including deaths on the field of battle.

What of those who "recovered"? How do disabilities resulting from gas compare with those from other causes? In the matter of total or partial blindness we may compare the average of less than one in two thousand due to gas with the average of more than one in two hundred due to other causes. Over 6 per cent of the "recovered" casualties due to causes other than gas lost one or more extremities or the flexibility of one or more joints. Gas caused none of these disabilities. Finally, army records show that, contrary to popular belief, the rate of incidence of tuberculosis was actually lower among the men who had been gassed than it was throughout the enlisted personnel in Europe.

Does the supposed relative inhumanity of gas reside in the pain inflicted? Not if we are to believe the testimony of the army surgeons and of the men who were themselves gassed. One is forced to conclude that it exists solely in the minds of certain misinformed or uninformed individuals.

Let us not be misunderstood. War is always, in all its aspects, appallingly inhuman. When, and if any effective means is devised to prevent wars we trust that we shall be among the first to acclaim it. In the meantime we do not seek to discourage those who would limit the horrors of war. If killing and maiming be forced upon us let us, by all means, kill and maim as effectively and with as little unpleasantness as possible. But let us first make sure of our ground.

Clearly the facts outlined do not constitute a good case for the provisions against gas warfare in the Geneva Protocol. The American Chemical Society has formally placed these and other facts bearing upon the subject before the Secretary of State and has made every effort to correctly inform the public. It furthermore requests that its members and all others interested in an intelligent disposition of this matter write to their Senators, plainly stating their attitude.

THE CENTENARY OF CANNIZZARO*

LYMAN C. NEWELL, BOSTON UNIVERSITY, BOSTON, MASSACHUSETTS

The year 1926 is the centenary of the birth of the famous Italian chemist, Cannizzaro. On May 22nd–June 1st a celebration of this event was held in Palermo, Sicily. A monument was erected to his memory and an address was delivered by Sir William Tilden who had performed a similar task at the meeting of the (London) Chemical Society on the occasion (June 26, 1912) of the observance of Cannizzaro's death, which occurred May 10, 1910.

No more appropriate place than Palermo could have been chosen for the centenary celebration. Cannizzaro was born in Palermo, July 13, 1826. Here he received his early education—a classical education consisting mainly of Latin, Greek, grammar, rhetoric, and mathematics. He won many prizes and attained special distinction in mathematics. In 1841 he began the study of medicine at the University of Palermo. Although he took no degree, he became deeply interested in physiology through the influence of his teacher Foderà. Four years later he went to Naples where he at once participated in a scientific congress by reading a paper in the physiological section. In Naples he met the physicist Melloni and worked in his laboratory. After a short time he was recommended by Melloni to Piria who was then professor of chemistry at Pisa. Piria aroused Cannizzaro's interest in chemistry, indeed the influence of the teacher was so marked that the pupil decided to devote his life to chemistry. We should note in passing that Cannizzaro's career at the outset was shaped by his teachers—a typical factor in his life and a debt he himself repaid many times over in his later years.

In 1847 Cannizzaro, inspired by youthful patriotism, left Pisa precipitately to join the rebellion in Sicily. Two years later, when events developed unfavorably, he and his zealous companions succeeded in escaping from Italy to France. Cannizzaro made his way to Paris where he entered the laboratory of Chevreul, doubtless through the recommendation of Piria and the personal intercession of Cahours. Research work in organic chemistry was resumed.

Cannizzaro returned to Italy in 1851, going to Alexandria and four years later to Genoa. In each place he was at first without a laboratory. Indeed he never had adequate facilities for work until he became well established in Rome many years after his first academic appointments. However, he did two things—kept on investigating in organic chemistry and took time to think about theoretical chemistry. The record of his

* Read before the Section of History of Chemistry at the Seventy-second Meeting of the American Chemical Society, Philadelphia, Pa., U. S. A., September 6–11, 1926. At the close of the paper Colonel Demetrio Helbig, a former student and assistant of Cannizzaro, addressed the Section.

investigations has been so often told that we shall pass it over with an occasional reference. But his contributions to theoretical chemistry deserve extended consideration.

Cannizzaro must have been thinking at this time (1851), probably earlier, about the fundamental questions of chemical theory centering around atomic weights. Like his contemporaries, he was confused and distressed by the chemical chaos of this period. The atomic theory of Dalton was about fifty years old but it had not been generally accepted because of the doubt arising from several sets of numbers called atomic weights. Moreover, there was depressing confusion caused by different conceptions of ultimate particles, especially the failure to distinguish between the terms atom and molecule. Indeed many chemists complacently ignored the term molecule and used the term atom to cover both atom and molecule. Again, despite accurate experimental work by Berzelius, Dumas, Stas, and others, the numbers obtained and called atomic weights were in many cases only equivalent weights, or combining proportions, which were not referred to any standard because no standard had been adopted. Even the term equivalent—a sort of last stronghold—was used in several senses. Avogadro and his hypothesis were "no man's land" to most chemists. Gay-Lussac was respected but his law was "explained" so generously that volumes of equivalents varied from $\frac{1}{2}$ vol. of oxygen to 2 vol. of NH_3. Even vapor densities, which, thanks to both Gay-Lussac and Dumas, could be readily and accurately determined, were merely used to check the empirical formulas deduced from analysis. As in the case of the phlogiston obsession, so here some chemists, like Laurent and Gerhardt, possibly Odling and Frankland, had clear conceptions but their views did not convince the majority. The situation has several parallels in the history of chemistry, situations in which many chemists pursued the broad and familiar highway regardless of the calls by the wise young men to abandon the old though rough road for an entirely new route.

Cannizzaro alone saw the way out of the maze. When he went to Genoa in 1855, as stated above, he must have already thought out the essentials of his famous method of determining atomic weights, because in 1858 the plan was published in the complete form as we know it. Cannizzaro at this time (1855) was scarcely 30 years old. He had been merely four years in an academic position (at Alexandria), and had published only a few papers (7 or 8). Yet he had worked out a plan of teaching the foundations of theoretical chemistry in the way that should cause us all to pause and consider our own methods. He says: "In order to lead my students to the conviction which I have reached myself, I wish to place them on the same path as that by which I have arrived at it—the path, that is, of the historical examination of chemical theories." This

plan was published in 1858 in volume VII of the Italian journal *Il Nuovo Cimento*. The communication did not appear as an ordinary article but as a long letter from Professor Stanislao Cannizzaro to Professor S. de Luca, and was entitled *Sunto di un Corso di Filosofia Chimica Fatto nella Reale Università di Genova*. The first word of the title is usually translated "outline" or "sketch," though a better interpretation is "abridgement." It is not correct to render it by the word "summary."

Contrary to the widespread belief, the *Sunto* was not a single meteor which fell into the murky chemical atmosphere of the 1850's. The same volume (VII) of *Il Nuovo Cimento* contained three other contributions in theoretical—or as Cannizzaro called it—philosophical chemistry. And a little-known article entitled "Lessons on the Atomic Theory Given in the Royal University of Genoa in 1858" was printed in an obscure journal published in Genoa (*Liguria Medica, Giornale di Scienze mediche e naturali*, Genova, Numeri 5 e 6, 1856). This significant article is reprinted (pp. 58–83) in the memorial volume of Cannizzaro's papers on the atomic and molecular theories issued in 1896 at Palermo on the occasion of his seventieth birthday.[1]

This year (1858) then was really the culmination of several years of reflection and actual teaching. The *Sunto* is available in English as Number 18 of the Alembic Club Reprints and in German as Number 30 of Ostwald's "Klassiker der Exacten Wissenschaften."

The essential feature of Cannizzaro's method of calculating atomic weights is so familiar that there is no need of expanding it at this time. It is in all text-books in chemistry and is known to beginners whether in high schools or colleges. However, we should not overlook the three distinctive features of Cannizzaro's contribution, *i. e.*, he recognized clearly the distinction between the terms atom and molecule, utilized Avogadro's hypothesis in finding molecular weights, and referred the weights of the elements in the molecular weight of their respective compounds to a common standard, *viz.*, H = 1.

Although I may be presumptuous, I cannot refrain from urging all teachers of chemistry, whatever may be their teaching field, to read, or re-read, Cannizzaro's own account of his famous method of finding atomic weights.

Our present purpose, as just stated, is not to expound Cannizzaro's method, but to point out some facts, not readily available, about the way in which the *Sunto* became a foundation stone of chemistry.

Early in 1860 when the confusion ("Verwilderung," Lothar Meyer called it) reached its height, about one hundred chemists gathered in Carlsruhe, Germany, in response to an invitation sent out by Weltzien, Würtz, and Kekulè. They assembled on September 3, 1860. It was a notable

[1] A copy of this book autographed by Cannizzaro was exhibited by Professor Newell.

company. The best known men of that time attended and there were a few young men, too—Kekulè, Würtz, Mendelejeff, Dumas, Boussingault, Odling, Frankland, Liebig, Kopp, O. Erdmann, and, among the younger men, Lothar Meyer and Cannizzaro. The congress, as it is often called, was a failure. Most of the members presented specific questions through committees. As usual there were interminable discussions about details and insistent demands for adoption of personal views. And, despite the pressing need of escape from overwhelming difficulties, the members dispersed without general acceptance of a single fundamental principle. Contrary to traditional belief Cannizzaro did not read the paper which has become famous. He participated in the discussions and was bold enough to insist that organic chemistry is subject to the same laws as inorganic—a position which was opposed by Dumas who was presiding at that particular session. What he did do has been briefly told by Lothar Meyer, though the story was really delayed until 1891 when Meyer edited the German translation of Cannizzaro's *Sunto*. Cannizzaro, it appears, distributed reprints of the *Sunto* and Lothar Meyer put a copy in his pocket to read at his leisure. He was deeply impressed with the clearness of the article and the completeness with which the difficulties about atoms, molecules, atomic weights, and molecular weights were removed. In 1862 Meyer made public his confidence in Cannizzaro's method of finding atomic weights and in 1864 the young German chemist paid tribute to the young Italian chemist by incorporating and developing Cannizzaro's views in his book, "Modern Theories of Chemistry." It was not until 1891, however, that he told the personal part of the story.

Other chemists besides Lothar Meyer must also have been convinced that Cannizzaro had solved the problem. English chemists surely were, because in 1862 Cannizzaro, although only 36 years old, was elected a Foreign Member of the (London) Chemical Society at the same time as Kekulè, Marignac, Pasteur, and Stas. The two English chemists, Frankland and Odling, had seen the value of Cannizzaro's method, possibly at the Carlsruhe Congress, and quickly used it in their teaching and writing. Chemists of other countries were soon convinced that it is better to adopt a general principle which yields consistent results rather than to magnify certain exceptions (*e. g.*, incorrect molecular weights from anomalous vapor densities). So Cannizzaro's table of atomic weights was promptly, though quietly, accepted in place of the numerous national tables, which after all were mixtures of atomic weights and equivalent weights, arbitrarily selected and personally, or racially, advocated. Before many years had passed Cannizzaro's method of finding atomic weights was incorporated in the text-books and used without question by chemists throughout the world. Cannizzaro himself evidently sensed the victory long before the warring chemists realized the battle was ended, because

he quickly returned to organic chemistry and published nothing in theoretical chemistry for about ten years. In 1871 he wrote an historical paper on the application of the atomic theory to chemistry and the system of formulas expressing the constitution of compounds; in 1872 he delivered the Faraday lecture before the (London) Chemical Society in which he again discussed theoretical chemistry; and in 1875 and 1878 he published two short papers on molecular combinations and anomalous vapor densities.

Cannizzaro was really an organic chemist. Of his 80 odd papers, 56 were organic, 12 theoretical, 4 physical, 5 biographical, 2 educational, and 4 miscellaneous. His organic work, except at the very beginning of his career, was devoted to the complex organic compound santonin.

Cannizzaro made many friends. Piria and Bertagnini come first. Next, doubtless, should come his students and then his own professional colleagues—Koerner, Lieben, Amato, Valente, Carnelutti, Gucci, Sestine, Paternò, Blaserna, R. Schiff, U. Schiff, Villavecchia, Ciamician, and many others. In France, England, Germany, and Russia his friendships began with Chevreul, Frankland, Liebig, and Mendelejeff, and included the famous chemists of these countries for over 50 years. The high place Cannizzaro held in the chemical world is seen by the universal expression of appreciation and good will on his 70th birthday. Felicitations were sent to him from chemists and chemical societies throughout the world, a medal was presented to him from his "Ammiratori-Amici-Allievi Italiani e Stranieri," eulogies were delivered, and a memorial volume was issued containing Cannizzaro's papers on molecular and atomic theories and chemical notation (happily published in Palermo). The American Chemical Society sent the following:

> American Chemical Society. To our illustrious fellow-member, Prof. Stanislao Cannizzaro: The officers and members of the American Chemical Society have the honor of extending to you their heartiest congratulations upon the attainment of your 70th year.
>
> All American chemists gratefully recognize the service which you have rendered Chemical Science in laying one of its foundation stones, and they wish most ardently to express the hope that many years of activity are yet in store for you, and that with ripening years new discoveries bearing witness of your great wisdom and keen thought may enrich the science in which you have already done such great work.
>
> With profound esteem and hearty greetings, we are your colleagues,
>
> CHAS. B. DUDLEY, *President*
> ALBERT C. HALE, *Secretary*
>
> Done by order of the Council, at Altoona, Pennsylvania, U. S. A., this first day of June, 1896.

Among the personal tributes was one from Professor John W. Mallet of the University of Virginia in which he expressed the hope that Cannizzaro would be spared a long time to guide us in the path of science and progress.

Reading this collection of "Onoranze,"[2] I was profoundly impressed with the names of the men who sent letters. No prominent name is lacking. From this collection one can almost reproduce the world picture of chemistry in the last decade of the 19th century. Moreover, practically every aspect of Cannizzaro's life is contained in letters which are models of expression in both language and love. At the end of the printed "Onoranze" there is a list—a very long list—of the names of the chemists and associations that contributed to the celebration of the birthday of the man whose years were three score and ten but whose wisdom was not to be measured by figures.

Cannizzaro did not stop working after his 70th birthday—except long enough to rest from the celebration. His investigations were continued though he published very little. His teaching, writing, editing, administrating, and serving were pursued with the zeal of youth.

At eighty years of age other honors were bestowed upon him. In 1906 the Sixth International Congress of Applied Chemistry was held in Rome. Paternò was President and Villavecchia was Secretary. Cannizzaro was Honorary President. Homage was paid him in many ways at this Congress. Relieved of the harassing details and oppressive labors so often demanded of a president, he was free to receive his friends and share in the deliberations of the Congress. The regard for this veteran and victor among chemists was shown in a most thoughtful way. Instead of presenting him with an illuminated address of welcome, or a purse of gold, or a jubilee volume, they gave him a bronze replica of Giovanni da Bologna's statue of Mercury.

When I visited Cannizzaro three months after the Congress had adjourned, I saw this statue in a conspicuous place in his living room. He welcomed the young chemist from America, talked about the astounding advances in industrial chemistry, expressed regret that Italy had so little money for higher education, but over and over again he talked about that statue of Mercury. He was not only pleased to know his friends wanted to recognize his approaching eightieth birthday, but the statue—just think, the famous Mercury! He showed me his books, his laboratory, his class-room, and his workshop, and all the while students came to him with questions, for this man of eighty years was teaching a double course (quite unusual in Italian universities), supervising the work of several graduate students, editing an Italian chemical journal, and performing the countless tasks connected with the administration of an important department in a large university, and with the obligations of a Senator of the Kingdom. In saying good-bye, I told him I was going on to Florence where I should take a glance at the original statue of Mercury in the Bargello. "It is true," he replied, "but I can see mine every day."

[2] A copy of the "Onoranze" autographed by Cannizzaro was exhibited by Professor Newell.

Soon after I returned to America I received a large engraving of Cannizzaro inscribed in his own hand-writing. The portrait represents him as sitting and the expression on his benign face is one of confident repose, yet I shall always think of his statue of Mercury for it typifies the swift message of truth that sped from the youthful Cannizzaro throughout the world of chemistry in those dark days so many years ago.

Dark Colored Rubber Wears Better Than Light. The color of a rubber article may prove to be one of its most important properties, for recent experiments in the rubber laboratory of the U. S. Bureau of Standards have shown that the darkest colored rubber objects stay "alive" longest when exposed to sunlight. A piece of light colored rubber retains its life very well when it is kept in the dark but deteriorates rapidly in the light. Tests were made and it was learned that different colors caused rubber to age at different rates. The advantage of using dark-colored compounds in rubber articles that must be exposed to the sun is pointed out.

Two test compounds were made; one to which two per cent carbon black was added as coloring matter and another which was colored with the same amount of red oxide. Three samples of rubber, one uncolored, one black, and the other white, were together exposed to sunlight for six months. Tests made at intervals to determine the rate of deterioration of each, indicated that the uncolored compound lost its life about five times as fast as the black but only about two times as fast as the red. The quantities of coloring matter added were not enough to affect the strength of the compounds.—*Science Service*

Sprayed Apples Safe, Expert Announces. The bubble of British alarm over arsenic poisoning derived from the spray materials left deposited on apples imported from Canada has been pricked by results of a recent scientific survey and analysis.

Dr. Frank T. Shutt, Dominion chemist, has found after extensive tests that a very large proportion of Canadian sprayed apples are entirely free from arsenic. The samples of fruit on which arsenic was found have such small quantities as to require four dozen apples to supply the largest dose permitted by medical practice, he declares in a report of his findings.

There has been considerable agitation over sprayed apples as a source of recent cases of arsenic poisoning in the British lay press and in medical journals, and the chemical analysis was undertaken to ascertain the precise status of sprayed apples as a menace to health. There has been a considerable falling off in the importation of Canadian apples as a result of the generally expressed alarm, it is said.—*Science Service*

Animal Experiments Are Open to Public. Experiments on animals necessary for the progress of medical knowledge do not take place behind barred doors, despite the claims of the antivivisectionists.

The animal rooms of medical laboratories are always open to responsible visitors according to a survey of the medical colleges and research institutes of the country, recently conducted by the American Association for Medical Progress.

Several directors extend special invitations to officers of humane societies so that they can see for themselves the exact conditions under which animals are kept for experimental purposes. Some laboratories will only receive visitors who have seen operations performed on human beings because it is argued that only in this way can a lay person appreciate the similarity between the two and the care taken against inflicting pain and avoiding infection.—*Science Service*

Dr. W. D. Coolidge, Assistant Director of the Research Laboratory, General Electric Company, and inventor of the cathode-ray tube.

THE CATHODE-RAY TUBE—A NEW CHEMICAL AGENT

GUY BARTLETT, GENERAL ELECTRIC CO., SCHENECTADY, N. Y.

Cathode rays have been known for many years and have been used in numerous important experiments, but not until now has there been a tube which could produce the rays, or streams of electrons, in considerable quantities outside of the generating tube, nor a cathode-ray tube that could be sealed from the vacuum system and thereby made portable and as easy to use as the modern X-ray tube. A new type of tube, answering these specifications, has now been produced by Dr. W. D. Coolidge, assistant director of the research laboratory of the General Electric Company. With it numerous chemical, physical, and physiological experiments have been conducted with startling results.

One of the most interesting experiments, from the viewpoint of the chemist, has been the production of a yellow solid when the cathode rays are passed through a chamber containing acetylene gas. Depending upon the electrical conditions, this substance can be collected either as a light, fluffy powder or as a varnish-like film which adheres tightly to metallic surfaces. The compound has defied all attempts to dissolve it in the solvents so far tried. Polymerization of the acetylene gas is a possible explanation of the reaction produced upon acetylene by cathode rays, but that this is true has not yet been determined. The solid, which has been produced in gram quantities with cathode rays, seems to be similar to, if not the same as, the substance produced in minute quantities from acetylene when affected by the beta rays of radium or by a corona discharge. Other substances, such as castor oil, also can be solidified by exposure to the rays.

An additional insight into the power of the new tube (Figs. 1 and 2) is given by the statement that it produces as many electrons per second as would a ton of radium, if there is such a quantity of that rarest of rare substances. The cathode rays from the tube and the beta rays from radium are alike in that they are both streams of high-speed electrons, although the radium rays are of higher average velocity than those emitted by the tube. A velocity of more than 150,000 miles per second has been attained with a voltage of 350,000, and the design of the tube is such that even higher voltages can be employed, with a resulting even nearer approach to the 186,000-mile velocity of light and electricity, than which, it is believed, there is nothing faster.

Radium is constantly disintegrating and bombarding its electrons into space, in spite of anything man might do to control it; the cathode-ray tube is an electronic source that at all times is under the control of the operator.

The Tube Itself

Cathode rays were first known within evacuated tubes. Then came the discovery that the rays could be obtained outside of a vacuum tube by

FIG. 1.—Leonard Dempster with two cathode-ray tubes, 55 inches long and with 12-inch bulbs.

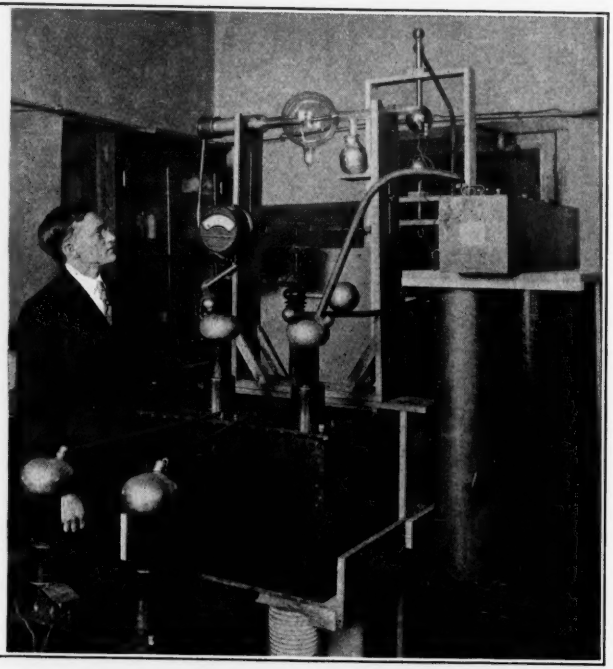


FIG. 2.—H. E. Tanis, Jr., with cathode-ray apparatus.

cementing a thin piece of metal foil over a small hole in a brass plate at the end of the glass tube and using it as a target, or anode, for the electrons bombarded from the cathode. The window was so small and the voltage so low with preceding tubes, however, that the quantity of rays produced was negligible in comparison with the quantity it is possible to produce with the new tube.

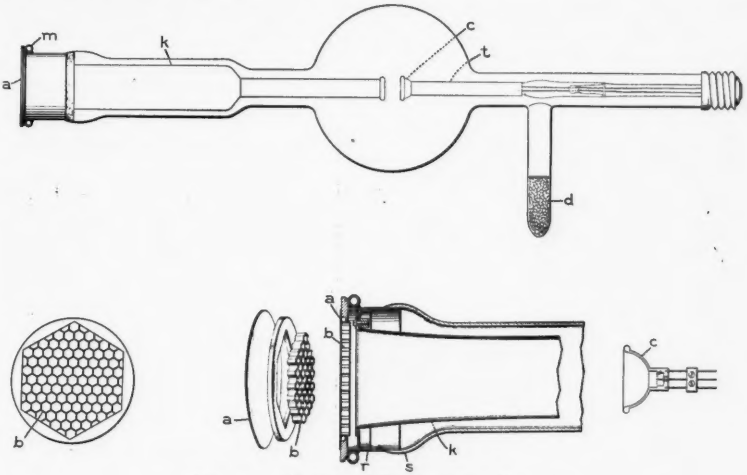


FIG. 3.—Diagram of Cathode-Ray Tube.

Upper—Diagram of tube.
Lower left—Construction of window.
Lower center—Details of window, shield and seal.
Lower right—Section of cathode.

a. Anode window, a very thin piece of nickel foil, through which the electrons pass into the air. *b*. Window support, a molybdenum hexagonal grid, to reinforce the window against the pressure of the atmosphere. *c*. Hemispherical cathode cup, focusing the electrons released by the tungsten filament within the cup. *d*. Charcoal trap for residual gases. When immersed in liquid air, the charcoal removes all traces of gases. *k*. Copper shield, preventing the electrons from striking the glass tube. *m*. Water-cooling tube, to prevent the window from becoming heated. *r*. Sleeve of invar, an alloy with about the same coefficient of expansion as glass, to which the anode is soldered. *s*. Glass-to-invar seal. *t*. Cathode shield.

Credit is, of course, due to the many investigators who experimented with cathode rays and tubes of preceding types. In developing the new tube, Dr. Coolidge devised a way of making a thin piece of metal—no thicker than a thin piece of paper and more than three inches in diameter—withstand a total atmospheric pressure of more than 100 pounds; he found how to use greatly increased voltages by shielding the glass tube so that it could not be punctured by the current; he incorporated many

developments originated while he was perfecting the X-ray tube; and he made his tube so flawless that, for the first time, it could be sealed off from a vacuum system and transported and used with ease (Fig. 3).

The electrons of the cathode-ray stream are supplied by a coiled tungsten filament, or hot cathode, heated to incandescence by a relatively low voltage. The other electrode, or anode, is the nickel window which is soldered to a disk of invar, an alloy which has practically the coefficient of expansion of the glass. Invar and glass can be fused together without danger of cracking upon being heated.

The electrons are released from the filament at a relatively low velocity—a few miles per second—but, by impressing high voltage between the electrodes—and up to 350,000 volts have been used—the electrons are driven from the hot cathode to and through the anode or window with a velocity of 150,000 miles a second, five-sixths the velocity of light.

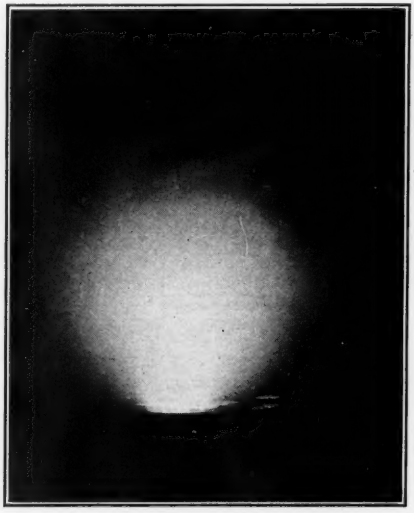


FIG. 4.—Violet glow of rays outside window or anode of tube.

The window is one of the most interesting parts of the tube. Although it is very thin—a half-thousandth of an inch—still, in terms of atoms and electrons, it is thick—a matter of about 50,000 layers of atoms in thickness. But, also in terms of electrons, the window hardly exists since there is so much space between the electrons forming the atoms of the nickel window. So the high speed electrons from the hot cathode keep right on going when they strike the window. Although the window hardly exists when electrons are concerned, it is a different story when molecules are considered. The molecules of air are successfully barred from the tube because the gas molecules, enormous in size when compared with electrons, are far too big to go through the spaces between the electrons in the nickel atoms.

The window has an area of about nine square inches and the atmosphere has a pressure of 14 pounds per square inch. The result is that this thin metal foil must withstand a total pressure of 100 pounds against the atmosphere, and to do this it needs assistance. This is supplied by sup-

porting it against a honeycomb structure of molybdenum. Such a structure has a maximum of strength with a minimum of cross-sectional area.

Another feature of the tube is the use of a protecting shield, a copper tube extending lengthwise from near the cathode and attached to the invar disk which supports the window. This tube confines the stream of electrons and keeps them from impinging on the glass. Thus high voltage discharges through the glass, with consequent punctures and destruction of the tube, are avoided.

When the tube is operated, the metal window or anode is surrounded by a ball of purplish haze (Fig. 4). Even in daylight it is discernible, and in a darkened room it is vivid. With an operating voltage of about 300,000, this spherical, glowing mass is about two feet in diameter, and more or less, depending upon the voltage employed. The odor of ozone or the oxides of nitrogen is also noticeable. The glow results from the ionization of the air by the cathode rays. The penetration of the rays depends upon the density of the matter which they strike, and, since the penetration in air is about two feet at 300,000 volts, it can be seen that solid substances are hardly penetrable.

Chemical and Physical Experiments of Many Kinds

The effect of the rays on acetylene is but one of many interesting results obtained with the new tube. To the uninitiated, one of the most astounding things done with the tube is the apparent production of a red-hot coal by momentarily turning the rays on a calcite crystal. And the luminosity lasts for hours. Although the glowing crystal is touched the first time with reluctance, it is exhibiting cold light, and there is no appreciable temperature rise. The casual observer sees only the bright orange glow, but the trained scientist sees more.

Bluish-white scintillations (Fig. 5*a*) are noticed during and immediately after raying and, by lightly scratching the surface of the crystal, these scintillations may be induced even an hour after raying. A scintillation causes loss of the orange glow in that part of the crystal. The spot where a scintillation has occurred is revealed by the microscope (Fig. 5*b*,*c*) as a tiny crater, with many canals leading from it. The microscope also reveals these craters as immediately below the surface of the crystal. High power microscopy reveals the network not as straight lines but a lines of small beads or globules (Fig. 5*d*). This beaded appearance is yet to be explained.

Calcite serves as an example of the effect of the rays on a crystalline substance. Celluloid, a non-crystalline substance, is affected similarly if exposed to the rays at liquid air temperature. In this case, however, the network is not of straight lines and sharp angles, but is composed

of waving lines. Figure 6*a* shows the effect of a short exposure to the rays, in which the craters are so few that their systems of canals are separable. Figure 6*b* shows the result of longer exposure to the rays, with the craters so close to each other that their systems of canals have become interwoven. Examination with the microscope shows that these electrical explosions occur within the substance, and a further proof of this is af-

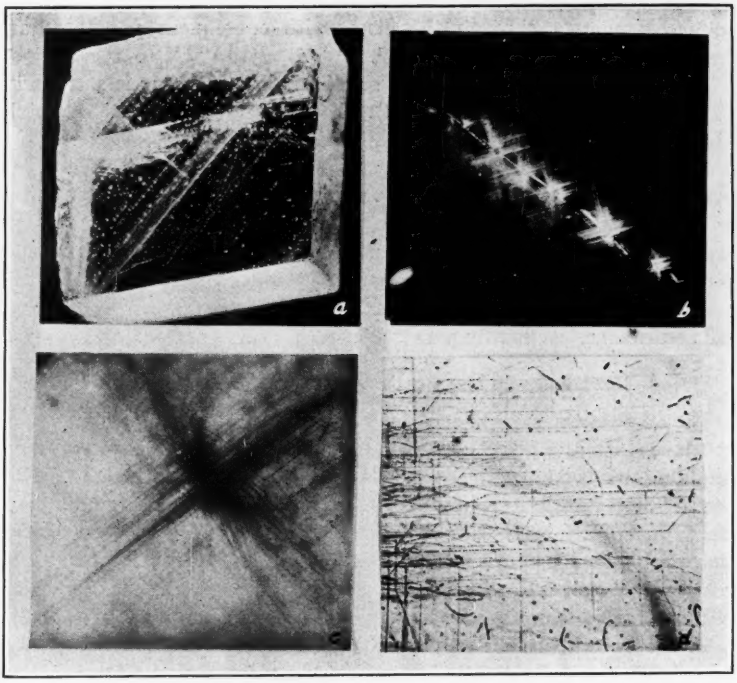


FIG. 5.—Effect of Cathode Rays on Calcite Crystal.

(*a*) Natural size photograph, showing spots at which scintillations have occurred. (*b*) Slightly magnified area, showing group of scintillation spots. (*c*) One scintillation spot under still higher magnification, showing crater and canals. (*d*) Section of a canal system under magnification of 360 diameters, showing globules.

forded with a piece of celluloid of which a part is very thin. Explosions will occur in the thicker portion of the celluloid, but not in the thin, circular region in the center (Fig. 6*c*), through which the electrons apparently pass without effect.

Several other minerals are caused to glow in the same way that calcite does, although with different degrees of intensity, with different colors of light, and for different lengths of time. Granite, composed of several

different minerals, shows orange, blue, red, and green. The colors are very brilliant while the rock is under bombardment, and persist for some time thereafter, although much less brilliantly.

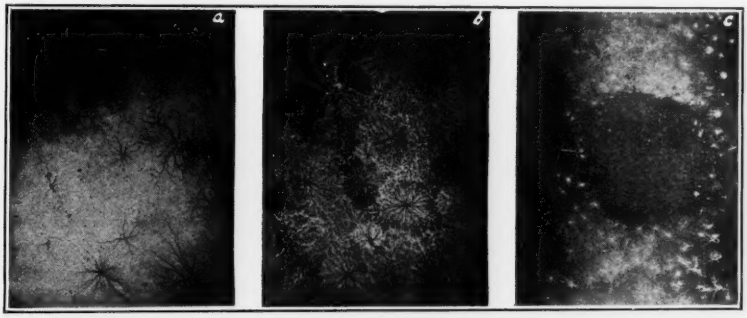


FIG. 6.—Effect of Rays on Celluloid at Liquid Air Temperature.
(*a*) Separated scintillations after brief exposure to the cathode rays. (*b*) Numerous scintillations, resulting from longer exposure time. (*c*) Showing penetration of very thin area of celluloid by the rays without scintillations.

At liquid air temperature, the scintillations or electrical explosions have been made to occur in many types of substances, such as minerals, organic compounds, and occasional inorganic ones. At room temperature only a few substances have shown scintillations, and at 180°C. they do not occur in calcite.

Clear fused quartz appears to the eye as a homogeneous mass, and is produced by melting together parts of water-clear crystals of the mineral. If a polished surface of the quartz is exposed to the rays for two minutes, it becomes purplish in color in irregular patches (Fig. 7). Heating removes the discoloration, but the same pattern can be produced again by raying the surface once more. The same effect is produced with a fractured surface of the fused quartz, indicating that the discoloration is not the result of the polishing operation. Quartz

FIG. 7.—Coloration of polished, clear fused quartz by the rays.

crystals do now show this discoloration, except that those from one location in New York State turned brown; the Brazilian quartz, used in making the fused product, remained colorless. The shape of the colored parts of the fused quartz is roughly that of the crystalline fragments which have been melted together, indicating that the purple discoloration may be due to chemical action of the rays on slight, colorless impurities in the fused fragments.

If sheet glue is exposed to the rays, it is apparently not affected (Fig. 8*a*), but the rayed area becomes white upon being heated (Fig. 8*b*). Microscopical examination of one of these heated areas shows the presence of many small bubbles (Fig. 8*c*). Gas is evidently formed by the rays, and the bubbles result when the glue is softened by the heat. Bubbles are similarly produced in cane sugar crystals, shellac, gelatin, etc.

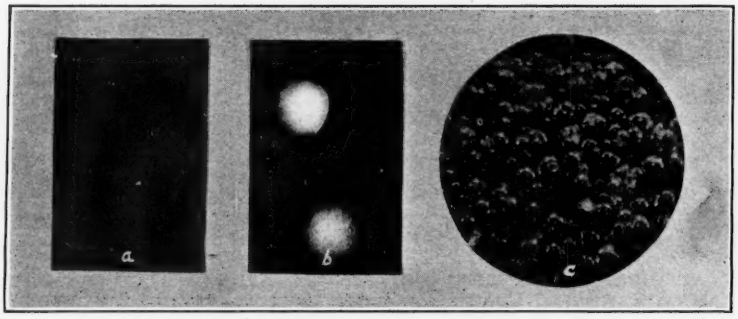


FIG. 8.—Effect of the Rays on Sheet Glue.
(*a*) Apparently unaffected after exposure to rays. (*b*) White spots caused by heating after raying. (*c*) Microphotograph showing bubble formation.

If ordinary salt (NaCl) is exposed to the rays for a moment, it turns brown. The effect is a surface one only, as is shown by removing the top layer. Potassium chloride is similarly affected, in that it becomes purplish. Glass assumes a purple or brown tint and can be marked with a metal stencil. So can porcelain and crockery. Such color changes are, however, permanent in only a few cases; at other times the color soon disappears.

Scientists working with cathode rays within the vacuum tube reported nearly fifty years ago that diamonds were discolored by the rays. With the new tube, working with electrons outside of the tube, no discoloration of diamonds by the rays has been noted, indicating that the previously noted color changes might have resulted from the spattering of the electrode material or from foreign matter being deposited on the diamonds.

A rancid flavor and strong odor result when the rays are turned on milk

or butter. Solutions of starch, cane sugar, and glycerin become acid to litmus upon exposure to the rays.

The phenomenon of thermo-luminescence can be shown very advantageously with the cathode-ray tube. A cadmium tungstate screen, ordinarily used for X-ray examinations gives off green light when subjected to cathode rays, and shows little phosphorescence or afterglow. Immersed in liquid air and then rayed immediately after being removed, the tungstate as it warms up shows several different colors, the color depending upon the temperature. If the screen is chilled after it has warmed somewhat, and is then allowed to warm up again no color is evident until it has reached the temperature which it had attained before it was rechilled. It then glows with the proper color for that temperature. By keeping the screen at a sufficiently low temperature, the radiant energy can be stored indefinitely, to be released by permitting the screen to warm up.

Effects of the Rays on Plant and Animal Tissues

Pricking the leaf of a rubber plant (Ficus elastica) causes the white latex or milk to be exuded. Raying an area of the leaf with the cathode-ray tube causes a similar flow of the latex (Fig. 9), indicating that the cell walls have been made permeable to the latex by the action of the rays.

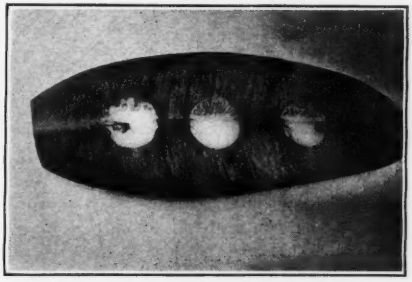


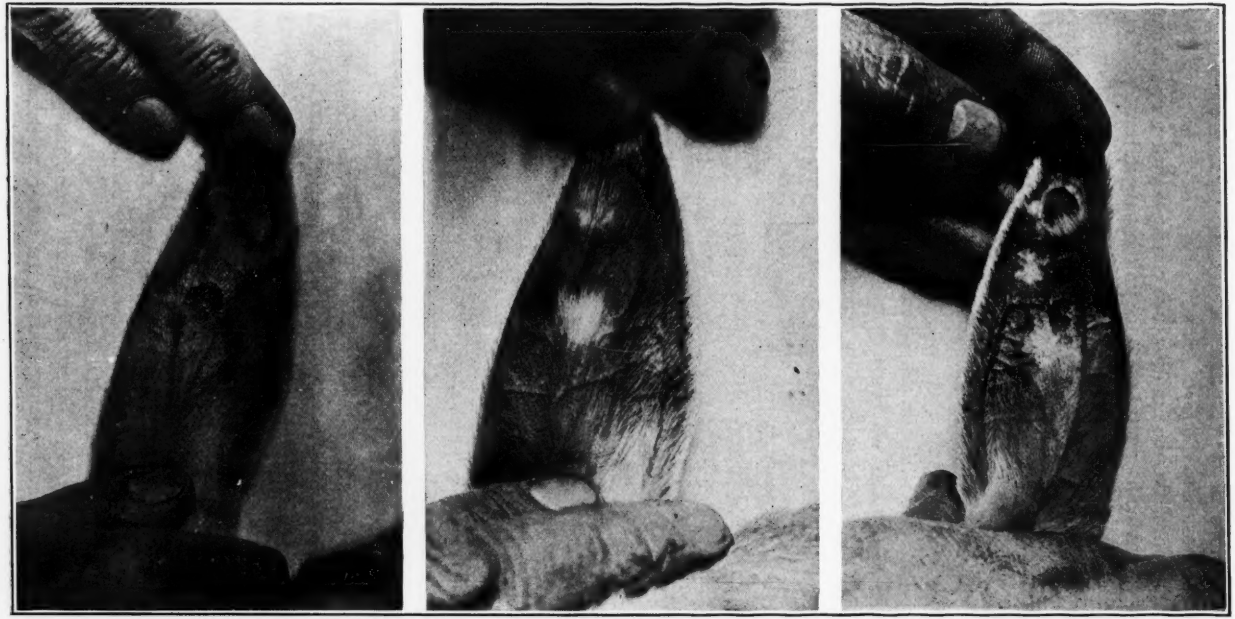
FIG. 9.—Effect of rays on leaf of rubber plant.

Experiments with bacteria, fruit flies, snails, cockroaches, and similar small forms of animal life have shown that exposure to the rays produces their paralysis and death.

The most interesting experiments with animal life have been conducted with a gray rabbit. Small circular areas of the ear were exposed to the rays for different durations of time. Exposure at 200,000 volts and one milliampere for 0.1 second caused the skin to become pigmented and the hair to fall out. Seven weeks later there was another growth of hair, the color of which was a mixture of white and gray (Fig. 10*b*, upper area).

The exposure on another area was increased ten times—to one second. In this case a scab was formed and, when it fell away, it took the hair with it. Three weeks later the area became covered with a profuse growth of longer, snow-white hair (Fig. 10*b*, lower area).

Exposure of a third area for 50 seconds caused the formation of a scab on each side of the ear. A hole was left in the ear when these scabs fell



(*a*) (*b*) (*c*)

FIG. 10.—Effect of Rays on Ear of Rabbit.

(*a*) Scabs formed immediately after raying: upper—exposure of 0.1 second; lower—exposure of one second. (*b*) Upper—growth of white and gray hair resulting from exposure of 0.1 second; lower—growth of white hair resulting from exposure of one second. (*c*) Hole, fringed with white hair, resulting from exposure of 50 seconds.

away, and weeks later the edge of the hole became fringed with the snow-white hair (Fig. 10*c*).

The commercial possibilities of the tube, still a laboratory development, are unknown, but it is expected that the tube will be invaluable in scientific investigations regarding electronic phenomena.

The first public demonstration of the new tube was given by Dr. Coolidge at a meeting of the Franklin Institute of Philadelphia on October 20, 1926.

Michelson Announces Final Figure for Light's Speed. The speed of light is 299,796 kilometers per second (186,284 miles per second). This is the final determination for the velocity of light as announced to the National Academy of Sciences at Philadelphia by Prof. A. A. Michelson of the University of Chicago and president of the academy.

This figure is the culmination of years of effort on the part of Prof. Michelson. He made his first experiments when a young officer on duty at the U. S. Naval Academy at Annapolis. Within the past three years he has been working at the Mount Wilson Observatory refining the figure for the velocity of light. The most accurately measured base line in the world, about twenty-two miles long stretching between Mt. Wilson and Mt. San Antonio, was used. Prof. Michelson projected a powerful light through a narrow slit onto a mirror which was spinning at the rate of about 30,000 revolutions per minute, which in turn projected it on a reflecting apparatus at the far station. The reflector returned the light to the original source. With an accurate knowledge of the rate at which the mirror is revolving and the distance between the two stations, the velocity of light can be calculated.

This summer Dr. Michelson made five series of observations with revolving mirrors having 8, 12, and 16 facets and all observations showed "remarkable agreement" which allowed the announcement of a final figure.—*Science Service*

Malaria Cure of Paralysis May Yield to Simpler Method. The growing medical practice of treating paralysis with a counter attack of malaria or rat-bite fever may be superseded by a much simpler process of injection with protein substances.

The latter, according to a report to the American Medical Association by Drs. M. M. Kunde, George W. Hall, and F. J. Gerty of Chicago, presents the advantage of not introducing a disease-producing organism into the system of the patient and is much more conveniently managed.

Malaria treatment requires the presence of a malarial patient as a source of infection, and such persons, thanks to present-day health campaigns, are not always to be found in many communities. In spite of the very beneficial results, however, that have been achieved by judicious administering of both this disease and rat-bite fever to paralytics, neither treatment is absolutely under control, a difficulty that may be offset by the new method, the Chicago doctors claim.

High temperature seems to be the agent that does the trick in straightening out the paralysis and this can be induced by protein injections more conveniently and without serious risk to the patient, it is said. The fever can be produced at will and regulated approximately by the size of the dose, the physicians declare.

"The improvements in the clinical symptoms of the patients treated at the present time are sufficiently encouraging," states Dr. Kunde, "to warrant our making this preliminary report with the hope that it may be given proper consideration by others who are interested in the treatment of general paralysis."—*Science Service*

SALVAGING THE SUPERIOR HIGH-SCHOOL CHEMISTRY STUDENT*

B. CLIFFORD HENDRICKS, UNIVERISTY OF NEBRASKA, LINCOLN, NEBRASKA

For the past three years one of the beginning chemistry courses at the University of Nebraska has, by means of tests or monthly grades, grouped its students upon the basis of ability and achievement.[1] This practice has proved so helpful that for several months the writer has been trying to think of high-school chemistry under similar administration.

Why Concern Ourselves with This?

There are a number of reasons for giving attention to the more capable of our high-school students. Investigations[2] have actually borne out the correctness of Doctor Monroe's statement,[3] "The tendency in our own schools is to devote more attention to the subnormal or mediocre than to the super-normal student." When 68 per cent of the total number of Indiana high-school seniors (1920) who were accelerated in the four years of their course were of less than medium mental ability it certainly does look as if mediocrity were in the limelight. Put in another way, that same survey found that only 6 per cent of those students having very superior ability were accelerated and that 3 per cent of those pupils of exceptional ability were actually retarded. Another study of high-school seniors[4] states, "The net effect of the (Iowa's) educational system is to level individuals toward mediocrity."

"One of the most vital questions in modern education centers around the needs of the bright student."[4] We teachers feel that he should be tomorrow's leader. If we believe that, can we do less than find this future leader and give him, at least, as much attention as his slow-moving classmate?

We seem to have the repeater, like the "poor," always with us. He is an educational liability. We have already given much attention to his case but if his numbers can be reduced the method bringing the reduction has our attention. As least two high schools[5,6] have definitely shown a reduced number of failures in courses where sectioning upon a basis of ability has been used.

A happy student is a desirable one, other things being equal. Benefits accruing from sectioning upon the basis of abiiity are described by one

* Presented before the Nebraska Academy of Sciences at Cotner College, Bethany, Nebraska, April 30, 1926.

[1] THIS JOURNAL, **2**, 655–8 (Aug., 1925).

[2] W. F. Book, "Intelligence of High-School Seniors," The Macmillan Co., New York, 1922, p. 68.

[3] "Principles of Secondary Education," The Macmillan Co., New York, 1922, p. 9.

[4] *Univ. of Iowa Studies in Educ.*, **2**, No. 5, 17 (1923).

[5] F. E. Clark, *Sch. Rev.*, **25**, 26 (1917).

[6] Gustave A. Feingold, *Educ. Admin. and Superv.*, **9**, 399–415 (1923).

writer as "improved scholarship, better states of mind, happier and freer spirits." Why? Probably because each student is working up to his level of maximum ability. Successful industry is a great aid toward happiness.

Our future leaders, most of us would say, should go to college. Yet surveys show that most of the students who go to college are "bad or questionable risks." One investigator[7] says 59 per cent are. Another[2] finds 65 per cent of the seniors having the lowest grades of intelligence are planning to attend college or, worse still, 25 per cent of students possessing the highest grades of intelligence are not thinking of attending college at all. If these super-normal students had had their ability made evident by tasks that challenged the best there was in them may not the story have been otherwise?

How Section According to This Plan?

In the larger high schools, where there are many sections of a given grade in one subject, the students in that subject are registered and given class assignments according to their intelligence quotients, grades in previous related class work and the personal rating by former teachers. Some schools have three quality sections: Honor, medium, and slow. Others use only two sections which they call A and B.

After the grouping has been made the group treatment may be varied in two ways; as to method of presentation and as to content. It is a common practice to give an expanded content with less drill for the superior group.[8] The usual content with more time for each topic, more drill, and a closer adherence to the previous assignment characterized the class work with the slower group.

Provision is usually made for the transfer of students from one quality section to the other as class and monthly tests indicate a need for such transfer. There is a double advantage to this as it provides an incentive to students to work at their best and keeps each section homogeneous.

Why Use This Plan in Chemistry?

High-school seniors both in Indiana[2] and in Massachusetts[7] who chose chemistry as a favorite subject were very generally the brighter students. There appears, according to one writer[2] to be a higher correlation between intelligence rating and grade in high-school chemistry than any other high-school subject. That doesn't mean, however, that every student *taking* high-school chemistry has a superior intellect. Nor does it mean that every student who comes to college chemistry has chosen chemistry as a favorite subject. In college chemistry we have many students who are

[7] *Department Inter. Bull.*, 9, 13 (1924).

[8] Gustave A. Feingold, *Educ. Admin. and Superv.*, 9, 485 (1923).

neither superior nor attracted by chemistry. We teachers of college chemistry covet more who are superior mentally and who find a satisfaction in chemistry. We recognize that probably not more than two out of every hundred in your high-school chemistry ever take our college chemistry. Yet, if by the aid of sectioning you can make certain that at least one of those two is of true college caliber we shall be grateful. We feel that we have justification for this request, for from these two students are to come the teachers and the creative producers of tomorrow.

It actually appears that the students from high-school chemistry are furnishing more than their share of these specialists. For instance Doctor Murry Hines of Northwestern University finds that in that university during "the past five years 4.6 per cent of those students entering with high-school chemistry completed a major in the department while but 0.8 per cent of those students entering without any previous chemistry completed a corresponding major in the department."[9]

How Section the Chemistry Class?

Most high schools give some of the standard intelligence tests to their pupils. All high schools keep a record of grades of their pupils in courses taken. These two items of data are available with but little trouble and by their use, especially the grades in sciences and mathematics, the probable honor and slow students may be found.

More specific in their prognosis than either of the above are the results from what are called placement tests. A set of these is put out by the University of Iowa for determining aptitude in chemistry. Their tests were planned for freshman college chemistry students. After having used them, however, with our students at Nebraska I see no reason why senior high-school students should not take them and the results be used for the purpose of sectioning quite as well as college students. The tests can readily be given at the first class period and scored so that assignment to the laboratory the following day may be made according to the results of the tests. If there are several class sections meeting at the same hour shifts may be made back and forth until one group is an "honor" class, another "slow," and, if there are three, a third "medium."

For small high schools, grouping the students into entirely distinct "honor," "medium," and "slow" classes will not be feasible. This does not mean that the spirit of sectioning upon the basis of ability may not be carried into the course, however. With this in mind the following suggestions are made:

During class periods the conference will need to be conducted at the "medium" level. Extra or special assignments should be regularly passed to the "honor" students. Such assignments should be more in

[9] Personal communication to the writer.

the nature of extension and further interpretation of general principles rather than descriptions of industrial applications. If possible, extra class time (not less than two periods per month) should be arranged for the slow students. One of these might regularly come just before the monthly test and be given to a drill and review as preparation for the test.

In the laboratory the "honor" student should be *held* for the quantitative experiments. He might well do many of the *demonstrations* for the others and very properly be excused from doing the simpler qualitative experiments. In general, this surplus time should not be used for chore work such as dish washing and storeroom management but for a further study of the more abstract phases of chemistry. Chores should more properly fall to the slow student. He needs the additional physical contact with laboratory and laboratory materials which such "chore-boy" work will give. The slow student will also absorb more than his due portion of the teacher's time in the laboratory. Thus by extra attention to these *two*—notice the "two"—extremes all the students of the class will be kept working more nearly at their mental levels.

Some one will remark, "That is no more than any successful teacher will do." Fortunately such is the case. Yet the Indiana survey, previously referred to, showed that practically 90 per cent of the superior high-school students in the senior classes of that state had never been discovered by their teachers or at least had not been motivated to the point of "skipping a grade." That prompts the suggestion that there should be a *conscious effort* made to find these capable students[2] even though nothing more than common-sense teaching practice is used afterward. The writer would personally like very much to find a half dozen or more teachers of high-school chemistry who would like to coöperate next year in trying out a plan of "finding and salvaging the superior high-school chemistry student."

In Conclusion

It is highly desirable that teachers recognize individual differences in students in their classes. Our best service to our community comes in finding and developing its leaders.

Our best aid toward the happiness of students under our instruction is given when we keep each fully and profitably employed at his mental level.

We are doing our institutions of higher education more than a favor by giving students in our classes advance estimates of their probable success in such colleges. Teaching upon a basis of ability helps to do that.

It has been shown:

That sectioning upon a basis of ability keeps the teacher conscious of individual differences.

That the superior mentality of the superior student is stimulated to greater effort by recognition so better leadership is developed.

That faster pupils are not bored by slowness of low group students, nor slower students so much discouraged when they are segregated; hence all are happier.

That tests given high-school seniors do indicate something of the chances of their success in college.

It is suggested:

Even though most of the chemistry classes are taught in small high schools it is possible:

1. To administer tests for aptitude in chemistry and determine students of different levels of ability and their chances for success in chemistry.
2. To apply the principle of sectioning upon the basis of ability and yet keep them all in one class conference.
3. To give better advice relative to vocational choices and college success by such administration.

Aviators May Carry Liquid Oxygen in Thermos Bottles. Aviators preparing to fly at high altitudes may now carry their oxygen supply in liquid form in thermos bottles and thus do away with the transportation of heavy steel cylinders containing the compressed gas. This is the invention of M. Garsaud of the French Academy of Sciences.

Not only is it easier to carry oxygen in this way, but larger quantities can be transported in a very small space. The bottles are made of enamelled metal and have two openings at the mouth, one leading the gasified oxygen into the mask worn by the aviator and the other for the passage of a wire carrying an electric current. The electric current heats a tiny quartz lamp inside of the bottle and thus vaporizes the necessary amount of oxygen.

The only inconvenience of the apparatus, M. Garsaud says, is splashing of the liquid oxygen in the bottle. This could cause explosion unless corrected by filling it loosely with asbestos.

Liquid air can be carried in these bottles for as long as six days at a time.—*Science Service*

Polarized Light Speeds Plant Growth. The latest prescription for anemic geraniums and discouraged ferns is polarized light. According to Dr. David I. Macht, plants exposed to polarized light grow at a faster rate than those exposed to ordinary light.

Dr. Macht worked with an artificially produced, or "synthetic" polarized light, the commercial application of which would be impracticable. But it is interesting to note that there is in nature a free source of polarized light in the moon. Light reflected at certain angles is polarized and, since moonlight is simply light reflected from the sun, it is largely polarized.

Thus, planting things "in the light of the moon," or "the dark of the moon," may at least possess a germ of scientific truth. Planted in the dark of the moon a seedling will be sprouted in time to get the light of the next full moon, but if planted in the light of the moon it will not have this advantage.—*Science Service*

SOME HISTORICAL ASPECTS OF CHEMISTRY

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After you have read what I have to offer you will probably decide that it is neither chemistry nor history, and my only excuse for offering it is based on one of those numerous questionnaires which chemistry teachers are so often asked to fill out. This one, in seeking to find what teachers wanted in a text-book, found that one of the leading aims of chemistry teachers was to give the pupils an appreciation of what chemistry has done to advance civilization. The value of this aim is recognized by the Prize Essay Contest Committee of the American Chemical Society in the choice of the subject, "The Relation of Chemistry to the Enrichment of Life." I believe the best way to secure this aim is to contrast the conditions of the past with those of the present.

We usually begin our study of chemistry with a study of oxygen and oxidation. This is the historical method of presentation and in following this procedure we are reliving the experiences of the race. There is a growing tendency on the part of the text-book writers to say less and less about the alchemists and their work. To me this is a very fascinating period in the history of science, and to give our pupils some background we should supply a few facts concerning the alchemist and his search for the Philosopher's Stone and the Elixir of Life.

Just when the study of alchemy began is hard to determine, but it is of very ancient origin. Some of the Old Testament stories probably formed the basis for some of these beliefs. The great age of some of the early Biblical characters was taken as proof of the common knowledge of the Elixir of Life by the ancients, and the episode of the Golden Calf was given as proof of the possibility of transmutation, for did not Moses grind the gold to powder and strew it on the face of the waters, thus showing its transmutation into some lighter material? During the unenlightened Middle Ages the belief in alchemy was very general. We are told that Edward I of England invited Raymond Lully to come from Milan to London where he was given very elegant quarters in Tower, and tradition tells us that he made approximately six million pounds sterling in gold and silver from lead, iron, and mercury.

From Germany, too, come many stories of the alchemists. On one occasion the celebrated alchemist manufactured several pounds of fine gold in the presence of the court of Rudolph II, which he presented to the ladies of the court. The Emperor was so impressed that he had a bronze plate set in the wall of the room, where the experiment was performed, to commemorate the event. We have also the story of Seton the Scot. He was travelling in Germany and, in an unguarded moment, he boasted of his ability to transmute metals. The Elector of Saxony seized him and

gave him a guard of honor of forty men to see that he did not escape. The Elector visted him daily and tried to persuade him to make some gold, but Seton was Scotch and stubborn and he refused. Finally, to force him him to action, torture was tried, but still he refused. At last he was rescued by a roving Polish knight, Micheal Sendivogens, but he died as the result of his torture. Sendivogens was an alchemist also and, as the story goes, he married Seton's widow, from whom he secured an ounce of a fine black powder, which was the true Philosopher's Stone. Sendivogens was quite a traveller and he had a magnificant coach, but he rarely rode in it. He usually rode on a mule with the rabble in his train, while an understudy rode in the coach. We are told that the understudy was kidnapped several times, under the belief that he was Sendivogens and that he carried with him the secret powder.

In 1404 the English Parliament made the making of gold and silver a felony, fearing that should its manufacture become general, the existing coin of the realm would become so debased as to be of little value. However in 1455, Henry VI, having become impoverished by the Wars of the Roses, granted a charter to a company to find the stone and manufacture gold so that the Crown could pay its debts.

The stories concerning the Elixir of Life are also interesting. More alchemists were credited with being successful in this search than in the other, for it was more difficult to check up on the results. Birth records were not kept, and if the alchemist were old, he claimed extreme age, and if he were young, he claimed that he would never grow old. Ponce de Leon's search for the Fountain of Youth is another aspect of the same idea. Only one story here is sufficient. This concerns the Count Saint Germain who claimed to have lived about a thousand years. He often told stories of his adventures with people who had been dead many years, and should any one question the truth of his story, he would turn to his servant and his servant always confirmed it.

On one occasion he was relating at dinner a conversation he had had with Richard I of England in Palestine during the Crusades. Some one expressed surprise and, as usual, he turned to his footman behind his chair and asked him if he recalled the incident. The servant replied, "You forget, Sir, I have only been in your service five hundred years."

"That is true," said the count, "I had forgotten. It was a little before your time."

Your pupils will always enjoy stories of this sort and will ask as one of mine did, "How could they get away with that stuff?" They got away with it because these ideas are the expression of two very human desires, the desire for wealth and the desire for eternal youth, and these desires are as strong today as ever. Quite recently a fellow citizen of mine paid five thousand dollars for a little machine to turn strips of newspaper

into twenty dollar bills, and people are buying under-water lots and oil stocks every day. Look, too, at the schemes for rejuvenation. Only last week I heard a man tell of restoring a woman of sixty-five to the first bloom of youth, by teaching her to breathe properly and, according to the newspapers, gland transplantations are due to take on a new lease of life.

The first chemical theory worthy of the name was the theory of phlogiston. This was based upon experimental observation. We must remember that a fire was a very much more important thing to our forefathers than to us.

Many of our city children, living in apartment buildings, have no experience with any fire except the gas fire in the kitchen range. Their homes are lighted by electricity and heated by steam, and they give little thought to the source of either. Our boy of three hundred years ago had a more intimate knowledge of fire. His only light at night was a candle or a rush light and his heat was from an open fire. Books were scarce and valuable, and a candle light was a poor light by which to read. He had no evening amusements, and all he could do was to stay at home and watch the fire. What is more natural than that someone watching the fire should begin to wonder, "What is going on there?" and from what he saw formulate a theory. He sees the flame spurt from the wood and decides that something is leaving the wood, and so he explains the phenomenon by assuming the existence of the new substance, phlogiston. This is one aspect of the scientific method. The fact that the conclusion was reached without sufficient evidence was unfortunate but immaterial since the mind works in a peculiar way. I know a little four-year old who pesters his father with questions, "What makes it go?" "How does it work?" and when his father tries to evade the issue and says, "I don't know", he asks, "Well, maybe how?" I think that shows better than any more learned dissertation ever can how our scientific theories are evolved. If we cannot see the mechanism we begin to wonder "Well, maybe how?" and imagine the method of procedure.

After Lavoisier's classic experiment with mercury finally overthrew the phlogiston theory, chemistry became a science and began to enter the industries. Unfortunately, it hasn't gotten very far into a few of them yet. Up to that time the idea that chemistry could ever be useful had seemingly never occurred to any one. It was a harmless pursuit, like collecting butterflies or postage stamps, but of no particular value. Soon Scheele discovered chlorine and its effect on organic coloring matters, and his active brain saw the value of the discovery. He hoped to see a great industry developed in Sweden, but he was disappointed, for an Englishman, not a Swede, developed the commercial process. A writer in the *Journal of the Society of Chemical Industry* describes an event as follows: "An anxious group is gathered on the plains of Holland waiting

for the coach. For several weeks they have received no cloth from England to bleach. At last the coach arrives and a man alights. It is a strange story he tells. They are to get no more cloth from England, for he says, 'They mix salt with black manganese and vitriol, and from this comes a foul gas, and by hanging cloth in it, they can do in a few minutes what we require months to do.'" This is one of the earliest examples of the destruction of an old established industry by the application of newly discovered principles.

All text-books have something to say of Priestley and his discovery of oxygen. It is possible to get reprints of his original articles and they form interesting reading. In spite of the fact that the discovery of oxygen was the death blow to the theory of phlogiston, until the time of his death Priestley was its firm supporter, and he waged a long and bitter controversy with Dr. John Maclean, of Princeton University, over it. Priestley's account of his tests of the effect of oxygen on animals and on himself is a wonderful bit of description. He tells of its action in supporting combustion and he wonders how it will affect animals, so he tries it on some mice. Having observed no evil effects on the mice he decides to try it on himself. He takes a whiff and awaits results. There are no evil effects, so he breathes a considerable quantity and sits down and writes of the sensations that a man experiences when he breathes pure oxygen. "The sun seems brighter," he says, "and I fancy there is a feeling of lightness in my breast," and he concludes by saying, "'Who knows but in the future this gas may not become an article of luxury for the rich, but so far only I and two mice have experienced it."

We are all familiar with the magazine advertisement which tells us that the ladies of antiquity anointed themselves with olive and palm oils in place of using soap. Have you ever thought of what happens when these oils are spread in thin films exposed to light and a moderate degree of heat? Rancidity develops, and these ladies were possibly more agreeable to the sense of sight than to the sense of smell. As people became more finicky, attempts were made to cover these and other odors by the use of perfumes and scented unguents. This is the origin of the perfume industry, which is the leading chemical industry of France. Soap could not become cheap until there was a cheap source of alkali, and this did not come until France, blockaded by the Allies, was forced to offer a prize for a method of producing alkali from products native to the country. As we all know the LeBlanc process was the result of this.

France did not profit much from this, for again it was England that captured the industry. The introduction of the process into England was not without its difficulties. The unrestrained evolution of hydrogen chloride killed off vegetation and dissolved the mortar from the walls of neighboring buildings, until absorption towers were provided which absorbed

the gas in water and ran the solution into the canal. All was well for a time and then the boatmen in the canal found the rivets and nails dropping out of their boats. At this psychological moment Deacon perfected his catalytic method for the preparation of chlorine which was used in the manufacture of bleaching powder, and the combination of these processes gave England its early supremacy in the manufacture of heavy chemicals.

The outstanding feature of the world's history since the discovery of America has been the development of colonial empires. Congested Europe needed an outlet for its population, and needed new sources of raw materials. At first the temperate and subtropical regions were occupied, and the raw materials were used about as they were found. Chemical processes found new uses and new products from the crude natural materials, and man advanced into the tropics. Tropical products became necessary to man's comfort, but the tropics resisted his advance. De Lesseps failed to dig the Panama Canal and many tropical colonies became the graveyards of political hopes. Pasteur, the greatest chemist that France has ever produced, found the key to the situation when he discovered that bacteria are the cause of disease. In the course of time yellow fever and bubonic plague, if not conquered, were at least controlled, and the tropics were made safe for the white man. Today the great motives back of the spread of colonial empire are the need of rubber and the need of petroleum. The work of the chemist in both of these fields is too well known to need comment. What will happen to some of these colonies when some chemist discovers a cheap synthetic process for the preparation will be hard to determine.

It is doubtless some exaggeration to say that the discovery of America was in part due to the lack of a sufficient supply of ammonia in Europe, but it has some elements of truth. As the urban population in Europe increased, the difficulty of providing food at a time when transportation methods were so primitive was very great. Meat, particularly, reached the consumer in a condition which we, today, would consider unfit for consumption. To make this more palatable spices were required, and, consequently, the trade with India developed. Had there been artificial refrigeration, and had meat reached the consumer as we get it today, it is quite possible that the discovery of America might have waited some time.

Wars and rumors of wars have played a large part in history. Never again can a horde of barbarians come out of the woods, or over the plains, and destroy a civilized nation by mere force of numbers. The value of mere man-power has been minimized by science. War is now a chemical industry and no nation or people can wage successful warfare without the aid of the chemist. While the chemist has made the warrior more efficient as a fighter, he has also increased his chances of living should he

be wounded. The two greatest factors in modern surgery are the results of chemical research, the discovery of anesthesia, and the discovery of antiseptics. During the Franco-Prussian War nine of every ten men who entered the hospitals in Paris died of infected wounds. "A pinprick is the open door to death," said the surgeon Velpeau. When Pasteur visited the surgical ward, the stench of suppurating wounds was so strong that he could not stay. The chemist has changed all this. The wounded man now enters the hospital reasonably sure that his wound will grow no worse, while only a few years ago the wounded who entered the hospital left all hope behind.

I am not a mind reader, but I know that some of you are wondering what good all of this stuff is. You can see no value in a paper of this kind. To my mind material of this kind has a very definite value. It challenges the imagination of your pupil. It compels his attention and encourages his interest and, finally, it makes him think, and this, after all, is the end and aim of education.

Believes Plant Specialists Should Solve Rubber Problem. Raising rubber trees so that they will give more of the milk that becomes the auto tire of commerce is more important than synthesizing man-made rubber in the laboratory, says Dr. L. E. Weber, rubber technologist of Boston.

"Under present practice the rubber tree yields about four pounds of rubber a year," Dr. Weber explained. "In the early days of the beet sugar industry the beet could only be made to yield two per cent of sugar. But the plant biologist got busy and cultivated it until he got a type that yielded just nine times as much. It may be fantastic to imagine that rubber trees could be bred to yield 36 pounds of rubber a year, but even if the present amount were merely doubled it would be an accomplishment unparalleled in its effect on the rubber industry of the world."

While the making of synthetic rubber may be one of the most fascinating problems of the chemist today, it is overshadowed in technical importance by the possibility of breeding better rubber trees, Dr. Weber believes.—*Science Service*

Studies Life in Giant Cells. How does the living stuff in plant and animal cells make its choice between what it lets in and what it keeps out?

This is the question attacked by Dr. W. J. V. Osterhout of the Rockefeller Institute, New York City, who spoke before the meeting of the National Academy of Sciences at Philadelphia recently, telling how he has been aided in his researches by the use of a tropical sea-weed named Valonia. Each specimen of this plant is made up of a single cell from one to six inches long—a gigantic size for cells which are usually so small that a microscope must be employed to see them individually. Because these cells are so large, Dr. Osterhout has been able to inject various solutions into them and then measure how fast the various chemicals can pass through the layer of living substance or protoplasm. Electrical charges seem to have a great deal to do with the secret, he says, for in solutions where the chemicals have broken down into ions carrying electrical charges they are not permitted to pass by the protoplasm, whereas chemicals that have remained as whole molecules, with neutralized electrical charges, in certain cases penetrate the living layer without difficulty.—*Science Service*

FROM ATOM TO LIFE*

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The structure of matter engaged the attention of philosophers of the East long before the days of Grecian Philosophy. Kanada, the founder of a system of Hindu philosophy, taught that matter is made up of exceedingly small, indivisible, eternal particles called atoms, which were supposed to be in perpetual motion and separated from one another by void space.

The ancient Greek philosophers were divided into two schools. On the one hand there was the school of Aristotle, called the Peripatetic, because the pupils received instruction while walking in the lyceum at Athens, who taught that matter is infinitely divisible. On the other hand, the school of Atomistic philosophers, led by Democritus, held that matter is finitely divisible, that is, composed of atoms. Democritus taught that atoms of different sizes and shapes, floating about in the void, impinge on one another, the atoms of similar form tending to group themselves together. The theory of the Atomistic philosophers contained the germ of the modern theory of the structure of matter. The speculation of the ancient philosophers constituted virtually all that was known about the structure of matter until the beginning of the nineteenth century, when John Dalton quickened the dead dogma of the philosophers into a living hypothesis.

A few years after Dalton propounded his atomic theory, Avogadro, an Italian scientist, introduced the term molecule (Latin, meaning *a little mass*). Since a molecule was assumed to be a cluster of atoms, the atomic-molecular theory suggested that matter has a "grained" structure. Ordinary matter appears to be continuous; but to explain the behavior of gases, liquids, and solids, we must assume that matter is discontinuous, or made up of exceedingly small, distinct particles. The idea of the discontinuity of matter is well expressed by Bertrand Russell in the following words: "To the eye or to the touch, ordinary matter appears to be continuous; our dinner-tables, or the chairs on which we sit, seem to present an unbroken surface. We think that if there were too many holes the chairs would not be safe to sit on. Science, however, compels us to accept a quite different conception of what we are pleased to call 'solid' matter; it is, in fact, something much more like the Irishman's net, 'a number of holes tied together with pieces of string.' Only it would be necessary to imagine the strings cut away until only the knots were left."

As is well known, scientists have been forced to assume the existence of particles still more minute than atoms; so Dalton's conception of the atom has been somewhat modified.

* Address delivered before the New Jersey Science Teachers' Association at Atlantic City, November 12, 1926.

The discovery of the electron by Crookes, in 1878, and its recent isolation and the determination of the value of its charge by Millikan have been of the greatest moment in the development of the physical sciences. Electricity is now regarded as being atomic in nature.

The discovery of the electron was followed, in 1895, by the discovery of the X-ray, which was followed a year later by the discovery of the Becquerel ray.

The discovery of the various types of radiation, followed by the discovery of radium with its marvelous properties, impresses upon us the meagerness of our knowledge and the limitation of our intellects. As expressed by an anonymous writer—

> For even the things which be in our hands—
> These, knowing, we know not—so far from us,
> In doubtful dimness, gleams the star of truth.

The discovery of radium has had a great deal to do with the newer knowledge of the structure of matter. This discovery is, indeed, one of the most important and brilliant in the history of the world, for it has created a new and wonderful science, namely, radio-activity. One discovery leads either directly or indirectly to another. Solomon said, "It is the glory of God to conceal a thing, but the honor of kings to search it out." The extraordinary properties of radium make it clear that atoms and molecules are no longer imaginary, but are real. In fact, we are now able to see the flash of light produced by a *single* charged helium atom shot from radium against a screen of zinc sulfide.

It is estimated that one gram of radium is continuously shooting off helium particles at the rate of 145,000 billion per second, with speeds which reach 12,000 miles per second. Radium also shoots off electrons, or beta rays, the speed of the particles varying, the maximum being nearly as great as that of light, which is 186,000 miles per second.

In this connection it is most interesting to note that Dr. W. D. Coolidge, assistant director of the research laboratory of the General Electric Company, has invented a vacuum tube—a cathode-ray tube—which produces as many electrons per second as a ton of radium—and it is estimated that there is only a pound of that rare metal in the whole world.

Radium is gradually and constantly disintegrating, and in so doing is firing electrons into space at a very high speed. The breaking down of radium is beyond our control, and is not influenced by anything we can do. Man can only look on and wonder. The cathode-ray tube likewise fires high-speed electrons into space, but at a rate that can be controlled by the experimenter, and in quantities far greater than by all the radium in the world.

According to information kindly furnished by the General Electric

Company, several unusual features have been incorporated in the new Coolidge tube. At one end of the tube there is an anode "window," three inches in diameter, of nickel foil the thickness of which is measured in thousandths of an inch. A heated tungsten filament, originally employed by Dr. Coolidge in the X-ray tube and now known to all as an essential part of radio tubes, furnishes the supply of electrons. The glass tube is shielded with a copper tube so that the stream of electrons cannot strike the glass and cause punctures, thereby permitting operation of the tube at voltages far higher than heretofore; and the tube is also the first which it has been possible to seal off from an evacuating system.

Electrons are given off by the heated tungsten filament, or cathode, at a mile or two per second. Between the cathode and the anode—the "window" and the copper tube which serves as a shield—there is impressed upwards to 350,000 volts of direct current. This causes the electrons given off by the filament to speed up to an average velocity of 150,000 miles per second or more, depending upon the voltage, within the short space of about one inch between the cathode and the copper shield tube. Having attained this velocity, the electrons coast the rest of the way through the tube and pass through the anode, or window, and into the atmosphere with but a slight diminution in velocity. While the nickel window appears to be solid to the eye, it is porous, and the electrons in passing through the window rarely hit a nickel atom in spite of the fact that there are about 50,000 layers of the nickel atoms.

Outside the window the electrons produce remarkable effects. When the tube is operated in a darkened room, a hum is heard and the window of the tube is surrounded by a ball of purplish haze, about two feet in diameter with 350,000 volts. This glow, which shows the penetration of the cathode rays in air, results from the particles of gases of the air being ionized by the rays or electrons.

So concentrated are the rays that many striking experiments have been conducted. Crystals of calcite apparently become red-hot coals when exposed for a moment to the rays, but they are glowing with cold light; a stick of lime has the appearance of red-hot iron, and a lump of feldspar glows with a variety of rich colors; acetylene gas is transformed into a yellow, insoluble solid; and a rabbit's gray hair has been destroyed, to be replaced later by a profuse growth of longer, snow-white hair. The rays induce chemical change and they will cause the death of small animals, such as mice. While the emanation has been referred to as a "death ray," it could never be employed for an army at a distance, for the electrons do not travel far through air.

The new Coolidge tube will probably be a valuable instrument for scientific research, and it may be of importance in medicine.

The atom as a whole is electrically neutral and it accords with the

known facts to assume that it is composed of tiny granules of negative and positive electricity, respectively known as *electrons* and *protons*. It appears, therefore, that Nature employs only two kinds of "bricks" in element building. The hydrogen atom consists of a positive nucleus (the proton) and one planetary electron. Under normal conditions the diameter of this atom is estimated to be about a hundred-millionth of a centimeter (2.54 centimeters = 1 inch), which appears to be about twice the usual distance of its electron from its nucleus. While the size of an electron is not known with accuracy, it is only a tiny fraction of the size of the whole atom, and the nucleus, or central sun, appears to be still smaller. An atom is therefore largely a vacuum. It has been computed that if the nucleus of a helium atom were represented by a pea, its two planetary electrons could be represented by two peas a quarter of a mile away. As stated by Bertrand Russell, the electron goes round its tiny orbit very rapidly, covering, under normal conditions, about 1400 miles per second, which means that it has to revolve seven billion times in one millionth of a second! Electrons, atoms, and molecules are far too small for our comprehension; they truly belong to the world of the infinitely little, to the ultra-microscopic world. It is a marvelous fact that these tiny particles, like the celestial bodies, are never at rest. What makes them move? We do not know. Perhaps the following lines of Vergil, as is suggested by J. W. Mellor, are as good a guess as any concerning the birth-history of motions:

> Know first, the heaven, the earth, the main,
> The moon's pale orb, the starry train,
> Are nourished by a soul,
> A bright intelligence, whose flame
> Glows in each member of the frame,
> And stirs the mighty whole.

Moseley's atomic numbers indicate that all the chemical elements constitute one family, each member of which is simply related to every other member. It appears that there is one primordial element out of which all substances are made, which is in harmony with the hypothesis of Prout. He suggested that the atomic weights of the elements—taking that of hydrogen as unity—were multiples of hydrogen, the lightest element. This meant that all the atomic weights of elements were whole numbers, and that hydrogen was the *primary form of matter*, of which atoms of other elements were aggregates. According to Prout, hydrogen corresponded to the *protyle* of the ancients. The hypothesis of Prout was found apparently to be untenable, for careful determinations of atomic weights showed that some of them were not even approximate multiples of that of hydrogen: for example, the atomic weight of chlorine is about 35.5. There is a great deal of interest in Prout's hypothesis at present,

for careful investigation by F. W. Aston, T. W. Richards, and others has shown that elements having fractional atomic weights, such as chlorine and lead, are mixtures of simple substances having atomic weights expressible in whole numbers, the mixtures being known as *isotopes* (Greek, meaning *equal* + *place*), because they occupy the same place in the periodic system.

The hydrogen nucleus or ion (H^+) appears to be one of the two fundamental units which have to do with the building up of more complex nuclei or atoms, the other unit being the light negative electron. Since the helium nucleus has a mass of 4, it may be regarded as consisting of four hydrogen nuclei and two electrons closely packed together. The helium atom contains, in addition, two exterior electrons. But if the helium atom contains four hydrogen nuclei, why is not its mass 4.032 when 1.008 is that of the hydrogen atom ($4 \times 1.008 = 4.032$)? There is a loss of 0.032 in the assumed transformation. In answering this question we must know that at present there is no real distinction made between matter and energy: matter is potential energy and energy is potential matter. Therefore, when four hydrogen atoms are assumed to come together to form an atom of helium, the excess of matter, namely, 0.032, should appear as energy. It has been computed that the transformation of one gram of hydrogen to helium would liberate energy equivalent to 166,000,000,000 calories! The conversion of hydrogen to helium would yield, therefore, immense quantities of energy, such as are found in the sun; and it may be that this change accounts, at least in part, for the tremendous heat of the sun. It is very interesting to know that both hydrogen and helium are conspicuous in the sun; indeed, helium was discovered in the sun many years before it was found in terrestrial matter. It should be stated that the experiments of F. W. Aston show that the average mass of the hydrogen nucleus, or proton, is very nearly 1.000 when packed in the nuclei of other atoms, which compares with its value of 1.008 in the free state. The helium nucleus of mass 4 is probably a *secondary unit* of great importance in the building of atoms. It has been suggested by Harkins and by Rutherford, that hydrogen and helium are the fundamental "bricks" out of which all other elements have been built.

Paneth and Peters of the University of Berlin claim to have transformed hydrogen into helium. They adsorb hydrogen on palladium and burn it off with slight excess of oxygen. The water is then condensed out by means of liquid air, the excess of oxygen removed with charcoal cooled in liquid air and the residual gas brought into a small capillary tube, and the electrical discharge from it examined for helium lines, external electrodes being employed to insure that the element does not come from the electrodes. They report that 10^{-6} cubic centimeter of helium was

thus prepared, and that they can detect as small an amount as 10^{-9} cubic centimeter of the gas.

Since the atoms of different elements seem to be fundamentally the same, the question of artificial transmutation is again confronting us. The following striking and significant passage is taken from R. A. Millikan's excellent book entitled "The Electron:" "But what a fascinating picture of the ultimate structure of matter has been presented by this voyage to the land of the infinitely small. Only two ultimate entities have we been able to see there, namely, positive and negative electrons; alike in the magnitude of their charges but differing fundamentally in mass; the positive being eighteen hundred and forty-five times heavier than the negative; both being so vanishingly small that hundreds of them can somehow get inside a volume which is still a pin point after all dimensions have been swelled ten billion times: the ninety-two different elements of the world determined simply by the difference between the number of positives and negatives which have been somehow packed into the nucleus; all these elements transmutable, ideally at least, into one another by a simple change in this difference. Has Nature a way of making these transmutations in her laboratories? She is doing this under our eyes in the radio-active process—a process which we have recently found is not at all confined to the so-called radio-active elements but is possessed in very much more minute degree by many, if not all, of the elements. Does the process go on in both directions, heavier atoms being continually disintegrating into lighter ones? Not on the earth so far as we can see. Perhaps in God's laboratories, the stars. Some day we shall be finding out. Can we on earth artificially control the process? To a very slight degree we know already how to disintegrate artificially, but not as yet how to build up."

Now, how does the organic spring from the inorganic? What do we know about the origin and growth of plants and of animals, and about the true nature of living matter? These are difficult and perplexing questions. We read in Genesis that God "formed man out of the dust of the ground," and that "every tree that is pleasant to the sight and good for food" was made to grow out of the ground. In Mark we read, "So is the kingdom of God, as if a man should cast seed into the ground, and should sleep, and rise night and day, and the seed should spring and grow up, *he knoweth not how.* For the earth bringeth forth fruit of herself first the blade, then the ear; after that, the full corn in the ear."

It is one of the extraordinary facts of biology that the same soil, air, water, and sunshine are able to produce not only such useful plants as wheat and maize, but flowers of exquisite beauty and fragrance, such as the lily and the rose, as well as the thorn and the thistle.

They are supplied with the same elements, but we know virtually

nothing about Nature's method of producing such a variety of plant life, nor really what life is. As expressed in the oft-quoted lines by Tennyson—

> Flower in the crannied wall,
> I pluck you out of the crannies,
> I hold you here, root and all, in my hand,
> Little flower—but if I could understand
> What you are, root and all, and all in all,
> I should know what God and man is.

We do know that plants, in their growth, are able to utilize the lifeless, inorganic materials found upon the surface of the earth, while animals are dependent either directly or indirectly upon plants. A tree, for instance, stands in the same place, perhaps for centuries, receiving its food from the air and soil, the former supplying carbon dioxide and water and the latter inorganic salts.

Protoplasm, a very complex, jelly-like material, is the basis of the cells or organisms. It consists of proteins, which are nitrogenous bodies. What is life? No one really knows, but we do know certain tests for life, one of which is *growth*. T. R. Parsons says: "All that association of phenomena which we term life is manifested only by matter which is made up to a very large extent of proteins, and is never exhibited in the absence of these substances." Proteins are the most complicated substances which have ever been investigated, and they have very heavy molecules. The molecular weight of hemoglobin is probably over 16,000.

Proteins build and repair tissues, and if only small amounts of fat and carbohydrate are present, proteins serve as fuel for the bodies of animals. When the chemist knows more about the nature and structure of proteins we may know more about life.

Various theories have been advanced to explain life, but no one of them is satisfactory. Very recently Dr. George W. Crile, of Cleveland, has written a book entitled "A Bipolar Theory of Living Processes." Dr. Crile advances the view that life is essentially a result of oxidation which depends upon the generation of electric charges in the cells of living organisms. He suggests that the cell is a kind of voltaic cell in which the nucleus is the positive element, the cytoplasm the negative, this idea being based on the fact that the nucleus is comparatively acid, while the cytoplasm is comparatively alkaline, the two being separated by a semi-permeable membrane. This would constitute essentially an electric cell.

In spite of all the attempts to explain life, we may still ask—

> And yet, to me, what is this quintessence of dust?

Chlorophyll, the green coloring matter found in plant cells, is also a

very complex material. Without it the higher orders of plants are not able to feed upon inorganic matter. Non-green plants, such as fungi and mildew, procure their food from other sources, such as dead organic matter.

Professor Willstätter of Munich has made the interesting discovery that the chlorophyll of plants and the hemoglobin of blood may be regarded as being derived from a common substance, namely, *aetioporphyrin* ($C_{31}H_{36}N_4$). By reduction and saponification of chlorophyll and of hemoglobin, Willstätter is able to produce aetioporphyrin (*Berichte*, **47**, 2831 (1914)). Chlorophyll is a complex magnesium compound, while hemoglobin contains iron. It is noteworthy that chlorophyll releases oxygen from carbon dioxide, while hemoglobin takes up oxygen. It is also interesting to know that Willstätter has studied many flowers of variegated colors, and he finds that these colors have at their basis a common substance. When a green plant is exposed to sunlight, certain rays are absorbed and in the presence of little bodies called chloroplasts carbon compounds are synthesized from the carbon supplied by the carbon dioxide of the air. This process is called *photosynthesis*.

The simplest carbohydrate capable of being formed by the action of a single molecule of carbon dioxide upon a molecule of water is formaldehyde (CH_2O). It is of much interest to note that formaldehyde has been found in plant tissues. In photosynthesis there is evidence that formaldehyde is formed and that six molecules of this compound come together to form a molecule of its polymer, glucose, a simple sugar:

$$\underset{\text{Formaldehyde}}{6CH_2O} \longrightarrow \underset{\text{Glucose}}{C_6H_{12}O_6}$$

Professor Baly, an English chemist, succeeded in 1924 in producing formaldehyde by exposing carbon dioxide and water to short waves of ultra-violet light. When the solutions in which aldehyde is produced are made slightly alkaline, a syrup is obtained which contains sugars very similar to those occurring in plants. Some day an abundant supply of sugar may be produced by synthetic methods.

It is also of great interest to know that Professor H. S. Taylor and Dr. A. L. Marshall, of Princeton University, have succeeded in producing formaldehyde by the interaction of carbon monoxide and hydrogen in the presence of mercury atoms excited by a radiation emitted from a cooled mercury arc. Hydrogen atoms are produced when the diatomic hydrogen molecule (H_2) collides with the excited mercury atoms. It is possible that a hydrogen atom first unites with carbon monoxide, forming HCO, the latter then interacting with ordinary hydrogen to form formaldehyde:

$$H + CO = (HCO) \quad (1)$$
$$2HCO + H_2 = \underset{\text{Formaldehyde}}{2HCHO} \quad (2)$$

The process of respiration is characteristic of all living things whether animals or plants; and so far as we know all living plants give off carbon dioxide as do animals. Green plants absorb carbon dioxide in sunlight and give it off in darkness. Green pigment of leaves contains exceedingly small particles of a body known as *chloroplast*, which is distributed through the protoplasm of cells. The chloroplast is the most important, yet most minute, factory known; for without it all life would perish. In this tiny factory cellulose, starch, sugars, etc., are produced. Indeed, carbon fuels, which we burn to produce energy, were once synthesized in this magic factory. The chloroplast transforms the energy of sunlight into the storable form of carbon compounds.

The human body is a wonderful chemical laboratory. "Within the boundaries of even a minute cell there are dozens of different principles, myriads of molecules which defy the power of the finest optical instruments."

The blood is a marvelous fluid, containing numerous components some of which are exceedingly complex. Chemists have devoted a great deal of attention to the study of the blood, knowing that health depends upon a proper adjustment of its components. It is estimated that there are about 25 trillion red cells or corpuscles in the blood of the average man. Anemic persons have too few red cells or else the cells are deficient in iron. The blood also contains white cells, or *leucocytes*. These cells are not so numerous as the red cells and are not very well understood. There are two different kinds of white cells, one variety being known as *phagocytes*, or "eater-cells." These are active in ingesting and destroying waste and harmful material as well as bacteria. The blood normally contains a substance called *opsonin* which whets the appetite of phagocytes for bacteria, so that they are eaten in bunches rather than one at a time. It is thus seen that phagocytes play an important part in combating germ diseases.

The calcium ion (Ca^{++}) is very important in the chemistry of the blood. In case of rickets and certain other diseases it may be much reduced. Other ions, such as the sodium, potassium, magnesium, and chlorine, are also delicately balanced in the blood. Too high a concentration of potassium ion (K^{+}) may produce paralysis of the heart, the rate of heartbeat dropping to zero, while an excess of calcium ion is very toxic. We are, indeed, "fearfully and wonderfully made."

The hydrogen-ion concentration, or acidity of the body fluids, may now be measured, which is of great importance. Saliva is nearly neutral, while the gastric juice contains a considerable quantity of hydrochloric acid. It is still higher in the gastric juice of the dog, which is able to digest bone. The term *hyperacidity* is employed to denote an excess of acid, while *hypoacidity* means that there is a scanty secretion, as in anemia,

cancer, gall-bladder, heart disease, beri-beri, and pellagra. Certain bacteria cannot exist in media which are too acid; consequently they are conspicuous by their absence in the stomach, but are present in vast numbers in the intestines. The acidity of the blood is practically constant.

In recent years scientists have devoted considerable attention to the study of glands or organs of secretion. Glands of the animal body are divided into two groups—(1) *glands with ducts* and (2) *ductless glands*, or *endocrines* (Greek, meaning *within* + *separate*). Glands having ducts pour their secretions into the stomach, intestines, or elsewhere for purposes of digestion. These are well illustrated by the salivary glands and by the pancreas. The ductless glands, or endocrines, pour their secretions directly into the blood stream. They supply *hormones* (Greek, meaning *excite*), or chemical messengers. These substances circulate in the blood-stream and produce activity in, or exert control over, various parts of the body. Some of the hormones act like very powerful drugs. There are a number of ductless glands, some of the most important of which are the *suprarenal*, the *pituitary*, the *thyroid*, and the *islets of Langerhans* in the pancreas.

The suprarenals, or adrenals, owe their name to their situation, which is just above the kidneys. Adrenalin (epinephrin) is a pure principle which was first prepared from the suprarenal glands. Its chemical structure has been determined and the complex compound is now produced artificially. Adrenalin is a very powerful and exceedingly useful drug. For instance, when injected hypodermically, it allays very quickly the spasms of acute bronchial asthma. It also has great potency in arresting hemorrhage and is a powerful heart stimulant. The power of the drug is graphically told by Dr. G. A. Dorsey in the following words: "It influences some tissues when diluted to one part in 100,000,000. It depresses the intestinal canal when diluted to one part in 330,000,000! What such dilution means has been worked out in terms of street sprinklers each of 625 gallons' capacity. A procession of such sprinklers twenty miles long and 200 to the mile would hold just enough water to dilute one ounce of adrenalin down to one dose." According to W. B. Cannon, adrenalin comes to our aid in time of emergency, enabling us to fight harder and to accomplish almost superhuman tasks.

The pituitary gland is located near the center of the head, and is about the size of the tip of the little finger. Starting with this gland, Dr. J. J. Abel has recently prepared a tartrate which is extremely potent. To quote Dr. Dorsey again, "Recall the twenty-mile procession of street sprinklers required to reduce an ounce of epinephrin [adrenalin] to a test dose; to reduce an equal amount of Abel's pituitary hormone would require not twenty miles of sprinklers, but 5000 miles!"

It is believed that giantism is caused by too much activity in the

anterior lobe of the pituitary gland. Machnow, a Russian, was exhibited in London in 1905, at the age of twenty-three; he stood 9 feet, 3 inches in height and weighed 360 pounds. Magrath, the famous Irish giant, had a pituitary as large as a hen's egg. On the other hand, certain noted dwarfs have been known to have small pituitary glands.

The organs of our bodies contain many principles and their study is opening up a new chapter in medicine and in life. Gland therapy is just in its infancy, and great discoveries may be expected in this field. There are many mysteries connected with the numerous principles of our bodies and with the complicated molecular changes that accompany the growth of living matter.

> We are such stuff
> As dreams are made of, and our little life
> Is rounded with a sleep.

Brazilian Tree Yields Leprosy-Curing Oil. The oil of a well-known Brazilian tree has been found effective in the treatment of leprosy and not as painful for the patient as chaulmoogra oil which has been used for centuries in leprosy cases in the Orient.

Dr. Antenor Machado, who has made a study of this new product, finds that it resembles chaulmoogra oil in many respects but that its acids have fewer methyl radicals which, he believes, are the chemical groups that have made chaulmoogra oil so dreaded as a medicine. The new oil has been used quite extensively of late in the treatment of leprosy, and the results have been eminently satisfactory, Dr. Machado says.

The tree from which the oil is obtained is known commonly as the sapucainha, and in botanical language as *carpotrochea brasiliensis*. An extract made from it has long been used as a household remedy for skin diseases.—*Science Service*

Scientists Undergo Slow Poisoning from Mercury Vapor. X-rays are not the only toys of science to extract a toll of physical suffering at the hands of their intrepid users.

The insidious poisonous effects upon himself of mercury vapor, utilized in a period of research experiments extending over twenty years, have just been described in a scientific paper by the famous chemist, Prof. Alfred Stock of the Kaiser Wilhelm Institute. Chronic troubles of the nose, throat, and intestines were rendered more aggravating by increasing nervousness and as time went on his naturally excellent memory and powers of concentration grew weaker and weaker. No course of treatment prescribed by his physicians proved permanently helpful.

Eventually it became evident that collaborators in his own laboratory as well as colleagues in other places were being affected in the same way. In consequence it was decided to readjust laboratory conditions so that as little free mercury would be exposed to the air as possible. And at the same time a thoroughly efficient ventilating system was installed.

In the course of a few months the various ailments fell off gradually and after a period of years health in some cases was restored completely when the experimenter refrained from further contacts with the fatal element.

Medical science, Prof. Stock declares, is not aware of the danger arising from the inhalation of mercury fumes, the chronic poisoning from which, in his opinion, is quite as fatal as the better known poisoning from lead.—*Science Service*

CLASSIFICATION AND SEGREGATION IN ANALYTICAL CHEMISTRY*

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The classification of students in analytical chemistry, according to ability, as early as possible in the beginning of the course is highly desirable. It enables those in charge of the course to carry out more efficiently the instruction by giving to the inferior students more help and special attention, and to the superior students more advanced material and heavier assignments. Moreover, if circumstances permit, the segregation of students into groups of approximately equal ability for lecture, recitation, and laboratory purposes has some decided advantages both to the instructor and to the individual student.

Some data on classification and segregation in the elementary courses in analytical chemistry given at the University of Pittsburgh during the past two years are here reported.

Elementary Qualitative Analysis

Fall Semester 1924–25

The instruction in this course embraces one lecture, one recitation, and six hours of laboratory work per week for one semester. The lectures cover the theoretical aspects of the subject. The recitations include weekly written homework based on sets of study questions, ten-minute written exercises, oral questioning, and discussion. The laboratory work consists of groups of preliminary experiments and the analysis of a minimum number (twelve) of unknowns. Four monthly examinations, together with a final examination, cover all phases of the instruction.

Classification.—As a basis for classification and segregation according to ability, three methods suggested themselves, namely: (1) using the students' grades from elementary inorganic chemistry (Chemistry 1 and 2), which courses are prerequisite to the present course; (2) a placement examination given at the first meeting of the class; (3) an examination given after the first few weeks covering the preliminary subject-matter of the course. With the present class, the third method was followed. After this first examination, the members of the class, a total of 73, were arranged according to their scores which ranged from 91 down to 10.

That this method of classification is fairly accurate is shown by the final attainment of the class. No student in the upper third failed, only four fell below the grade of 70 (60 is passing), and eleven received a grade of 80 or better. In the middle third, only two students received a grade of over 80. In the lower third of the class the highest grade reported was 73, eleven received grades of 60–63, and seven failed. The averages of

* Delivered before the Division of Chemical Education at Tulsa, April 6, 1926.

the semester grades for each third were, respectively, 77.2, 63.2, and 56.3. Data for this appear in Table I.

The semester grades of the class were correlated with the scores of the first examination, the computation being made by aid of an Otis Correlation Chart. The correlation coefficient was 0.71, showing a fair degree of correlation. A comparison of the inorganic chemistry grades showed many inconsistencies, making them practically useless as a basis of classification, the correlation coefficient being 0.56.

Segregation.—The classification determined above by the method of a first examination was used to segregate the class into three recitation sections. This was done by placing the upper third in a superior section, the middle third in an average section, and the lower third in an inferior section. This gave homogeneous groups in which the instruction and assignments could be adjusted to the ability of the group. In general, more advanced material was introduced for discussion in the superior section and little or no time was lost by unnecessary reviews of the simpler fundamentals involved. On the other hand, the inferior section required much drilling on fundamentals and even at times a review of certain phases of elementary chemistry. An attempt was also made to adjust the nature of the written quizzes according to the abilities of each group.

In Table I are tabulated the percentages of each section whose semester grades fell between the indicated limits.

TABLE I

QUALITATIVE ANALYSIS 1924–25

Section	Superior	Average	Inferior
Number of students	24	23	26
Withdrawals and incompletes	1	3	3
Average semester grade for section	77.2	63.2	56.3
Percentage of section with semester grades	%	%	%
Between 90–100	8.7	0.0	0.0
Between 80–89	47.8	10.0	0.0
Between 70–79	26.0	20.0	21.7
Between 60–69	17.4	35.0	47.8
Below 60	0.0	35.0	30.4

Elementary Qualitative Analysis

Fall Semester 1925–26

Classification.—The scope of this course, method of instruction, instructional staff, grading system, etc., were the same as with the foregoing class. The class numbered 107. The classification rating was made on the results of the first examination covering the first few weeks of work. The scores for this examination ranged from 100 down to 14. As with the foregoing class, this method of securing the relative rating proved

surprisingly accurate, as shown by the final outcome. No student in the first quarter of the class fell below a semester grade of 70, and all grades above 90 were in this quarter. The highest grade reported in the fourth quarter was 73. No failures occurred in the first and second quarters, two in the third, and fourteen in the last quarter.

Segregation.—On the basis of this classification the class was divided into an upper and a lower lecture section, and these lecture sections again subdivided into recitation groups consisting of 27, 27, 27, and 26 students, respectively. Student schedules and facilities did not allow any segregation in the laboratory, so it was chiefly in the recitation groups that this selective instruction could be followed and the results could be measured. The results are tabulated in Table II.

TABLE II

QUALITATIVE ANALYSIS 1925–26

Section	Superior	High average	Low average	Inferior
Number of students	27	27	27	26
Withdrawals and incompletes	1	0	1	3
Average semester grade for section	79	71	67	56.6
Percentage of section with semester grades	%	%	%	%
Between 90–100	11.5	0.0	0.0	0.0
Between 80–89	42.3	18.5	7.7	0.0
Between 70–79	46.1	40.7	38.5	13.0
Between 60–69	0.0	40.7	6.1	26.0
Below 60	0.0	0.0	7.7	61.0

The distribution of grades among the four sections shows that the sectionizing was for the most part correct. The progress of all students was carefully watched throughout the semester, in order to determine whether any should have been shifted to another section, but a general redistribution seemed unnecessary, although some overlapping did take place. On the other hand, the data in themselves do not give a final answer to the criticism that the student's interest and industry, and consequently his grade, are influenced by the standards set by the section to which he was assigned. This question is discussed in more detail under the results obtained by use of a balanced section.

Elementary Quantitative Analysis

Spring Semester 1924–25

This course follows the qualitative course and covers one semester of study. The division of the student's time, methods of instruction, instructional force, grading system, etc., were the same as in the preceding courses. The class numbered 53, of whom 9 were new students transferring from other institutions. Since most of the class were students who had

satisfactorily passed the prerequisite course in qualitative analysis at this institution, their capabilities were known and their grades obtained in the qualitative course were used as a basis of classification and segregation. The newcomers were given a special examination in qualitative analysis before being assigned to a recitation section; the result of this examination placed one of these new men in the upper third and the other eight in the lower third.

The final outcome, tabulated by sections, is given in Table III.

TABLE III

Section	Superior	Average	Inferior
Number of students	21	17	15
Withdrawals and incompletes	1	1	5
Average semester grade for section	82.0	65.0	63.6
Percentage of section with semester grades	%	%	%
Between 90–100	25.0	0.0	0.0
Between 80–89	45.0	18.8	0.0
Between 70–79	30.0	25.0	30.0
Between 60–69	0.0	37.2	40.0
Below 60	0.0	25.0	30.0

The data show that here again the sectioning was, on the whole, quite accurate. The correlation of the final semester grades here with the final grades in the preceding (qualitative) course was 0.92. The correlation of semester grades with the first monthly examination was 0.76 and with inorganic chemistry grades 0.52. The failures were all among those students whose qualitative grades were between 60–62. As with the other classes for which data are presented, the instruction in the recitation groups was more satisfactorily adjusted to the needs of the particular group.

Elementary Quantitative Analysis

Spring Semester 1925–26

This class numbered 79 students. The staff was the same as in the preceding courses. For the purpose of classification the scores of the first examination were used. That this proved to be as satisfactory a basis as the students' records in the prerequisite qualitative course is shown by the correlation coefficient which was 0.69 on the basis of the first examination scores as compared with 0.70 on the basis of the qualitative course records.

This class afforded the opportunity of testing out the effect of segregation on the student, that is, whether segregation into sections of equal ability is really the best thing for the individual student. The questions might be raised, might not, on the one hand, the inferior students' interest, attainment, and scholarship be improved by meeting in recitation groups with classmates of superior ability and, on the other hand, might not the superior students' enthusiasm and progress be retarded by being grouped

with the slower members of the class? To secure data on this point, a balanced section was formed by taking every fourth name from the classification list, thus giving a group of twenty individuals whose scores ranged from very high to extremely poor. The remaining members of the class were then divided into a superior, average, and inferior section. The pace set for the balanced section was approximately that of the average section. Data are given in the following table.

TABLE IV

Section	Superior	Average	Balanced	Inferior
Number of students	20	20	20	19
Withdrawals and incompletes	0	2	2	0
Average semester grade for section	80.4	71.9	70.4	62.7
Percentage of section with semester grades	%	%	%	%
Between 90–100	0.0	0.0	0.0	0.0
Between 80–89	50.0	16.6	44.4	0.0
Between 70–79	45.0	38.8	5.5	21.0
Between 60–69	5.0	44.4	33.3	58.0
Below 60	0.0	0.0	16.6	21.0

The individual semester grades for the superior, average, and inferior sections were distributed as would be expected, showing that the method of classification and basis of segregation are consistently correct. With the balanced section, it will be noted that the heterogeneity of this group had little influence on the grades of the individual members; in other words, good students as judged by the classification rating maintained high scholarship throughout the semester and poor ones remained poor in spite of the intellectual quality of their recitation classmates, provided a fair average requirement of assignments be prescribed. A comparison between semester grades and classification scores for this balanced section showed a close agreement, the deviation becoming marked in only three cases. For a mixed section, the data show little influence of one student on another if the instruction is carefully planned and carried out. On the other hand, an inferior student being assigned to a section composed of superior students would no doubt soon find the pace too rapid and lose out completely, whereas a good student in a poor section is robbed of the incentive to develop himself to his fullest extent.

Summary and Conclusions

Data are presented for two classes in qualitative analysis and two in quantitative analysis which show that a satisfactory classification of ability can be made on the basis of examination early in the beginning of the course, and that the use of final grades obtained in the prerequisite inorganic chemistry courses as a basis of classification are much less reliable. The correlation coefficients are shown in the following table.

TABLE V

CLASSIFICATION CORRELATIONS

Class	Inorganic grades with semester grades	First exam. with semester grades	Qual. grades with semester grades
Qualitative 1924–25	0.56	0.71	..
Qualitative 1925–26	0.39	0.91	..
Quantitative 1924–25	0.52	0.76	0.92
Quantitative 1925–26	0.47	0.69	0.70

Segregation into sections of approximately equal ability for recitation and lecture purposes can be made from the classification rating with a fair degree of reliability, necessitating little or no subsequent redistribution.

In the following table are summarized the data on sectioning for all four classes exclusive of withdrawals and the balanced section, giving the total number of students in each section whose semester grades fell between the limits indicated.

TABLE VI

Final semester grades	Superior sections	Average sections	Inferior sections
Between 90–100	10	0	0
Between 80–89	41	15	0
Between 70–79	33	36	15
Between 60–69	5	43	32
Below 60	0	13	28

The table shows that the grouping into sections, using the classification rating, has been in good agreement with the students' capabilities. Segregation has solved a number of teaching difficulties, increased the morale, and bettered the attitude of the student and probably lowered the mortality.

Extracts from Brain Tissues Stop Bleeding. Dangerous bleeding after surgical or accidental injury to blood vessels may now be stopped by chemical substances derived from brain, lung, blood, or other body tissues. Herbert Hamilton of Detroit described at the last meeting of the American Chemical Society how substances of animal origin which cause the blood to coagulate more quickly are made. Extracts may be prepared from any tissues, Mr. Hamilton said, but those from the brains or lungs are the most effective. These substances are to be used by "bleeders," or hemophiliacs, as the doctors call them. They are persons with blood which fails to coagulate quickly enough or which does not form the right kind of clots.—*Science Service*

Chemist Makes New Synthetic Resin. A new resin, made of glycerin and carbolic acid, and used in the making of varnishes, molding powder and other substances, was described before the American Chemical Society meeting in Philadelphia by James McIntosh, of Bridgeport, Pa., the discoverer. After the glycerin and carbolic acid have been condensed the product can be made into an infusible, insoluble substance by a one or two-step process. The reaction can be speeded up by the addition of a hardening agent. The new resin is called acrolite.—*Science Service*

PREDICTING PERFORMANCE IN CHEMISTRY. II

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In an earlier publication[1] we described the Iowa Chemistry Aptitude Test and the Iowa Chemistry Training Test, with respect to content, method, and purpose. In brief, these examinations seek to enable teachers of chemistry, on the very first day of the school year, to estimate which students will do well and which poorly in the course that is to follow, and, if desired, to provide such special treatment as circumstances may warrant. These examinations along with similar examinations in other subjects have been given the general name "Placement Examinations." During the past school year (1925–26) more than fifty colleges and universities have used the Placement Examinations in chemistry. While many institutions which used these examinations have made incomplete reports or none at all, we have accumulated a large amount of data. These data represent a wide sampling of the "*status quo*" of the freshman mind, its incumbrances (or lack of them) and potentialities, as observed at the beginning of the college year.

The portions of data here offered are intended to afford information on the following topics.

I. How accurately are students placed by the Iowa Placement Examination?

II. Are there notable differences in the quality of institutional groups of students taking freshman chemistry?

III. How much and what kind of chemistry is retained by freshmen who have had high-school chemistry?

We believe data satisfactorily answering these questions should include observations covering at least four or five years and a much larger number of institutions and students than are here represented. Further, because our information is insufficient compared with this standard and, because the conclusions to be drawn are of basic importance in forming teaching policies, we prefer to regard the observations here presented as *suggestive* rather than conclusive.

I. How Accurately Are Students Placed by the Placement Examination?

Before presentation of data bearing on this topic we wish to make the obvious comment that "the more nearly the Placement Examination and the final semester examination measure the same thing with the same rigor the better will be the agreement in results obtained." Further we wish to state that we know of no imperative reason why all colleges should teach identical courses in elementary chemistry, but that so long as the content of courses varies at different institutions the degree of

[1] THIS JOURNAL, 2, 701–8 (Aug., 1925).

accuracy of prediction based on placement examination scores will also fluctuate. So we are not surprised to learn that at different colleges the coefficients of correlation between placement examination scores and final semester grades vary from 0.23 to 0.85. Further, we learn that extremely low as well as extremely high coefficients of correlation are most frequently obtained with groups numbering from 15 to 30 students. In colleges where the group numbers from 100 upward, the coefficients range from 0.50 to 0.60.

To chemistry teachers who have not worked with statistics, statements of accuracy of placement in terms of coefficients of correlation are not especially enlightening. In each of the three tables which follow we have attempted a different mode of statement of the same facts.

TABLE I. ACCURACY OF PLACEMENT BY THE CHEMISTRY APTITUDE EXAMINATION

From use of the Iowa Chemistry Aptitude Examination at the following institutions: Case School of Applied Science, Missouri School of Mines, Montana State College, Utah Agricultural College, University of North Carolina. Total number of students included is 933.

Quarter	A, B %	C, D %	Total Pass %	Non-Pass %
1 (Highest	51	44	95	5
2	29	61	90	10
3	10	76	86	14
4 (Lowest)	1	59	60	40

Thus the upper line in the table reading across the page indicates that 51% of the students in the upper quarter of the 933 students involved made A or B, 44% made C or D, 95% of the upper quarter passed, and 5% of the upper quarter failed to pass. In the same table the last line indicates that in the lowest quarter 1% of the students made A or B, 59% made C or D, 60% passed, and 40% failed to pass.

The composition of Table II follows that of Table I except that it is based on results obtained from the Training Test scores of 444 students who offered entrance credit in high-school chemistry at the following institutions: Case School of Applied Science, University of Minnesota, Montana State College, and University of North Carolina.

TABLE II. ACCURACY OF PLACEMENT BY THE CHEMISTRY TRAINING EXAMINATION

Quarter	A, B %	C, D %	Total Pass %	Non-Pass %
1 (Highest)	66	33	99	1
2	31	62	93	7
3	23	50	73	27
4 (Lowest)	20	52	72	28

$N = 444$

Better placement of students who offer entrance credit in chemistry may be obtained by giving both the Aptitude and Training Tests and then

combining the scores. This was done with 166 students at Case School of Applied Science. Table III is based on results obtained at this institution.

TABLE III. ACCURACY OF PLACEMENT BY CHEMISTRY APTITUDE + CHEMISTRY TRAINING

Quarter	A, B %	C, D %	Total Pass %	Non-Pass %
1 (Highest)	67	33	100	0
2	35	51	86	14
3	24	39	63	37
4 (Lowest)	2	45	47	53

$N = 166$

We believe the foregoing gives a fair notion of what may be expected from the use of Chemistry Placement Examinations; *viz.*, a notable scholastic

TABLE IV. INSTITUTIONAL AVERAGES, IOWA CHEMISTRY APTITUDE EXAMINATION, REVISED, FALL 1925

(Perfect score, 115)

Name of College	Date given	Number	Mean	Median	Upper quartile[1]	Lower quartile[2]	S. D.[3]
1. U. of California	Oct.	640	65.42	67.22	78.16	54.08	17.55
2. Case School of Applied Science	9/23	182	73.74	76.59	84.82	64.41	15.11
3. Earlham College	9/21	64	52.66	52.89	63.50	40.50	15.88
4. Eureka College	9/18	32	42.97	43.61	49.17	34.17	12.68
5. Graceland College	Oct.	28	66.43	67.32	82.14	57.38	19.86
6. Greensboro College	9/11	80	34.88	32.95	43.21	24.00	14.85
7. U. of Iowa	9/23	356	47.46	46.79	58.59	34.92	17.46
8. Kansas State Agr. College	10/1	85	59.78	60.46	71.38	44.75	17.17
9. U. of Minnesota	9/26	335	67.42	68.58	78.94	56.58	15.81
10. Missouri School of Mines	9/18	124	58.87	60.92	69.17	48.06	15.66
11. Missouri Wesleyan College		38	48.55	45.83	63.00	36.25	16.10
12. Montana State College	9/24	116	64.48	64.00	73.13	55.58	14.28
13. U. of New Mexico	9/6	37	41.22	42.68	45.99	37.64	6.41
14. U. of N. Carolina	10/19	70	63.00	64.64	76.72	48.33	18.73
15. U. of Oregon	10/9	189	55.10	53.38	69.66	43.01	19.63
16. Rutgers U.	10/31	65	77.31	79.46	87.84	67.66	13.10
17. Santa Barbara, Calif., T. C.	Sept.	16	69.38	75.00	82.50	60.00	16.57
18. Utah Agr. Coll.	10/29	123	44.92	44.22	56.53	31.42	17.38
19. U. of Washington	10/2	144	70.28	71.20	85.50	60.40	18.19
20. U. of Wyoming	Oct.	33	60.30	63.13	77.19	45.63	19.92
Composite of all colleges (18)			58.60	59.92	73.79	43.69	20.17

$N = 2032$

[1] The score above which are 25 per cent of the group tested.
[2] The score below which are 25 per cent of the group tested.
[3] Standard deviation (root mean square of deviations from the mean).

superiority of the upper quarter, scholastic inferiority of the lowest quarter, and moderately successful accomplishment for those standing in the middle 50 per cent of Placement performance.

II. Are There Notable Differences in the Quality of Institutional Groups of Students Taking Freshman Chemistry?

The results here presented fall in two groups, (*a*) data from the Chemistry Aptitude Examination given chiefly to students who had no chemistry in high school, and (*b*) data from the Chemistry Aptitude Examination given only to students who had chemistry courses in high school. Table IV pertains to the first of these two items.

In a general way the scores recorded in Table IV represent the native capacity of the freshman groups at the institutions named to accomplish whatever is required of them in the pursuit of a first course in freshman chemistry. A notable feature of this table is the rather narrow limits between which the mean scores fluctuate. East, West, country or city, large institution or small—the student in the middle of the class most often makes a score not varying widely from 60. This indicates that freshman chemical aptitude is much the same everywhere and that no college represented has a notable initial handicap or advantage in the quality of its starting material.

Similarly Table V contains mean scores obtained from the use of the Chemistry Training Examination at the institutions mentioned in the table.

TABLE V. INSTITUTIONAL AVERAGES IOWA CHEMISTRY TRAINING EXAMINATION CT-1, REVISED

(Perfect score, 188; highest individual score, 160)

Name of College	Date given	Number	Mean	Median	Upper quartile	Lower quartile	S. D
1. Poly. Inst. of Brooklyn	9/21	61	84.50	79.08	99.19	64.14	29.25
2. Case School of Applied Science	9/23	182	89.28	89.96	114.50	63.11	34.78
3. U. of Cincinnati	11/9	77	94.36	99.15	119.15	79.05	30.51
4. Earlham College	9/22	23	63.20	55.75	82.00	44.08	27.55
5. Greensboro College	9/25	10	31.50	29.17	37.00	17.84	20.02
6. U. of Iowa	9/22	77	54.73	49.00	69.25	37.19	27.97
7. Kansas State Agr. College	10/8	88	44.39	39.05	56.17	28.59	25.92
8. U. of Minnesota	9/26	337	65.45	62.34	89.40	38.11	35.11
9. Montana State Coll.	9/25	66	47.05	45.42	54.75	37.19	13.51
10. U. of N. Carolina	10/19	30	66.50	65.00	83.30	50.00	23.46
11. Rutgers University	10/30	67	90.32	94.50	116.00	82.67	25.10
12. Santa Barbara, Calif., T. C.	Sept.	16	70.13	64.50	79.50	47.50	26.21
13. Utah Agr. Coll.	10/29	68	67.15	63.79	85.50	50.17	26.15
14. U. of Washington	10/2	142	69.71	73.80	94.30	39.00	34.90
Composite of all colleges (12) $N = 1140$			72.97	70.76	97.18	46.54	34.88

Table V affords an index of the thoroughness of the chemical training given by high schools to the students in the various groups represented.

A study of Table V reveals the fact that, in any column in the table representing average group scores, the highest value is just about double the lowest. Further observation shows that the average score of the

lowest fourth at some institutions is higher than the average score of the highest fourth at others. No merit or lack of it on this account applies to the institutions concerned, since the thing measured is retention of chemistry learned in high school before coming to college. Whatever may be the causes of the conditions indicated, the fact remains that the problem of utilization of high-school chemistry as a basis for a differentiated freshman chemistry course will be a very different problem at different institutions. Further, the spread of scores in single institutions is such as to raise the question of the advisability of giving the same course to all who offer entrance credit in chemistry.

It is not easy to form a suitable theory explaining why freshmen at some institutions should display superior training in high-school chemistry as compared with groups at other institutions. It may be observed, however, that most of the colleges where high average scores were obtained are located in or near large cities located in highly industrialized parts of the country. A fair deduction is that most of these freshmen received their high-school training in large city high schools. Similarly it may be observed that many of the institutions, where low average scores were made, are located in less densely populated and less industrialized parts of the country and the conclusion would follow that most of these freshmen were drawn from small high schools. Following this course of reasoning comes the question, Is the quality of chemistry teaching in large high schools generally superior to the quality of chemistry teaching in small high schools? Objection may be raised as to whether or not the information and skill needed to make high scores in the test represent the most desirable kind of chemistry to be taught in high schools. Here we offer no justification for our selection of subject-matter contained in the Training Test other than that it seems to perform the services for which it was designed. Nevertheless, so far as our findings represent a valid sampling, there are small differences in the average ability of freshmen to learn chemistry, but great differences in the capacity of different high schools to teach chemistry.

III. How Much and What Kind of Chemistry Is Retained by Freshmen Who Have Had High-School Chemistry?

The data here presented were gathered from answers made by freshmen in the Chemistry Training Examination. This examination[2] is composed of four parts: the first, forty-five questions on descriptive chemistry; the second, forty-five questions on equations and formula writing; the

[2] A better understanding of the content of this examination may be had by direct reference to the Iowa Chemistry Training Examination. Teachers may obtain copies gratis by application to either of the authors. Those desiring a larger number of copies of either or both examinations may secure them at 3½ cents per copy from The Extension Division, University of Iowa.

third, fifty questions on the chemistry of industry and daily life; the fourth, twelve problems of graduated difficulty in chemical arithmetic. Table VI shows the distribution of scores made in each of these four parts of the examination. The freshmen who made these scores number 712, and were located at University of Cincinnati, University of Iowa, Kansas State College, University of Minnesota, Montana State College, and Rutgers University.

Reading down the column headed "Part 4, Chemical Arithmetic" the figures signify that 22.3% of the 712 freshmen made scores ranging

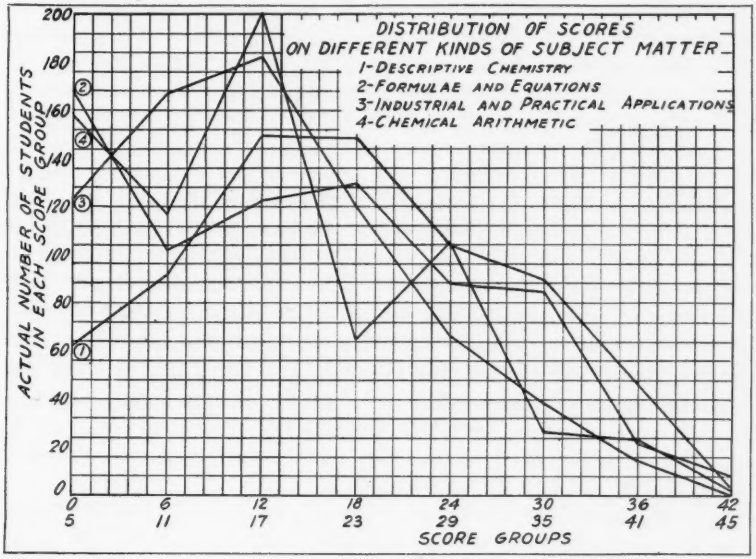

FIGURE 1

from 0 to 5 on this part of the examination; 16.65% of the whole group similarly made scores ranging from 6 to 11, and so on down the column.

Further, by direct proportion, it is easily computed that scores ranging from 0 to 5, where 48 is a perfect score, correspond to a range of 0 to 10.4% where 100% is a perfect score. In similar fashion, from the top two figures in each of the columns 2, 3, and 4 we learn that about 38% of all the freshmen involved made scores on these three parts of the examination corresponding to less than 25% on the basis of 100% for a perfect score. Only in descriptive chemistry is found an approximately normal distribution of scores, and here 65% of the group made scores ranging from 0 to 50% when 100% is construed to represent a perfect score. In Figure 1 are graphically represented the same data as are contained in Table VI.

The abscissas represent score groups exactly as represented in Table VI while the ordinates represent the actual numbers of students in each score group instead of percents as in columns 1, 2, 3, and 4 in Table V.

TABLE VI. DISTRIBUTION OF SCORES MADE ON EACH OF THE FOUR PARTS OF THE CHEMISTRY TRAINING EXAMINATION

Scores	Part 1 Descriptive Chemistry %	Part 2 Formulas and Equations %	Part 3 Industry and Daily life %	Part 4 Chemical Arithmetic %
0–5	8.83	22.91	17.27	22.30
6–11	13.18	13.91	23.53	16.61
12–17	21.31	16.78	25.48	28.83
18–23	21.17	18.00	16.85	9.51
24–29	14.72	12.41	9.74	15.05
30–35	13.46	11.73	5.29	3.97
36–41	6.73	2.86	1.81	3.26
42–45	0.56	1.36	0.00	0.42
Perfect Score:	45	45	50	48
$N = 712$				

A glance at the curves in Figure 1 indicates unmistakably that a very large proportion of the students did rather poorly in answering the questions in the Placement Examination. This showing may be attributed either to (1) extreme difficulty of the examination; (2) poor high-school preparation in chemistry; or (3) subject-matter covered by high-school chemistry not being the same as that covered by the Placement Examination. The following answer count is presented in order to throw light on the choice of alternatives.

EXAMPLES OF ANSWERS BY STUDENTS WHO OFFERED ENTRANCE CREDIT IN HIGH-SCHOOL CHEMISTRY

Answer count on 529 freshmen at Case, Cincinnati, Kansas State, Minnesota, Montana State, North Carolina, and Rutgers.

Example 1. (True or False)	Per cent answering correctly
Nitrogen is an active element	66.7
Right 353; wrong 149; omitted 27	
Example 2.	
Complete and balance $KOH + HCl =$	69.0
Right 365; wrong 44; omitted 120	
Example 3.	
Complete and balance $Al(OH)_3 + H_2SO_4 =$	19.3
Right 89; wrong 187; omitted 886	
Example 4.	
7 gm. of iron unite with 4 g. of sulfur. How many g. of iron sulfide will be produced?	68.6
Right 363; wrong 57; omitted 109	
Example 5.	
The atomic weight of H is 1; of Cl, 35.5; of Zn 65. What weight of Zn will be needed to generate 10 g. of H_2 using dilute HCl?	16.8
Right 89; wrong 114; omitted 326	

In a group where 31% fail to complete and balance KOH + HCl (Example 2) or are unable to see that 7 + 4 = 11 (Example 4) we believe we are warranted in assuming that about a third of the group learned nothing of equation writing or chemical arithmetic while in high school. High-school chemistry teachers may find comfort in the fact that if many freshmen got through high school without knowing much about chemical arithmetic, there was also a large number who got through without knowing much about *any* arithmetic as is evidenced by data gathered from the Mathematics Training Examination. The very first question in the examination was: Divide 5/7 by 6/11. Twenty-four per cent of 1534 engineering freshmen in 18 engineering schools in this country failed to get a correct answer for this simple problem. Further, while we have no quantitative data to offer, our own teaching experience indicates that many students who have taken freshman chemistry in our own classes are still unable to do much with chemical arithmetic or the writing of simple equations. The foregoing is not an evidence of the entire degeneracy of the teaching of chemistry in American high schools. Such is not the case, since the top third of students involved in this study requires no apology. But we believe that the evidence indicates rather conclusively that at least 20% of students who come from high school to college lack the ability to think in terms of symbols, whether these symbols be arithmetic integers, algebraic letters and signs of operation, or chemical formulas and equations. This proportion may be higher among students in high schools. We believe this lack of chemical aptitude is at least a partial answer to all three of the alternatives above-mentioned. If this conclusion be accepted, at least tentatively, we come to the question which may some day become an issue: If many students are unable to think abstractly in terms of chemical symbols and the implications associated therewith, which shall be eliminated, the abstract ideas or the incapable student?

In concluding this part of the present paper and in answer to the question, "How much and what kind of chemistry is retained by freshmen who have had high-school chemistry?" we may state that so far as present data go the indication is that about one-third have satisfactory preparation in all four divisions of chemistry here represented; that two-thirds do satisfactorily on descriptive chemistry, and finally that two-thirds do unsatisfactorily on both chemical equations and chemical arithmetic. Some idea of the present meaning of the terms "satisfactory" and "unsatisfactory" may be gained by reference to Table V or Figure 1, in connection with a copy of the Iowa Chemistry Training Examination.

Finally, we wish to acknowledge our indebtedness to the many chemistry teachers throughout the country whose labor and coöperation made this study possible.

THE VITAMINS. II

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Vitamin C ("Water-Soluble C")

A few centuries ago, fresh food in winter was so rare in Northern Europe that, for instance, when Catherine of Aragon, newly arrived in England as a bride, demanded a salad it was necessary for the royal gardener to journey to Holland to find the materials; and scurvy was so common that a medical writer seriously suggested that all diseases might be regarded as modifications or outgrowths of scurvy.

On the long voyages of the era in which America was discovered and explored, sailors at sea were often compelled to subsist for months upon rations consisting of little if anything but breadstuffs and salted or dried meats and fish. Under such conditions there were often severe epidemics of scurvy—sometimes with almost miraculously rapid cures when, through good fortune, a supply of fruit or fresh vegetables was found before the disease became too far advanced.

As in the case of beri-beri, there was, for long, a conflict of views as to whether scurvy were in fact a nutritional disease; but the nutritional theory gradually came to prevail. Fruit juice was officially adopted as a preventive of scurvy in the British navy. Medical men began to realize that, after the introduction of potatoes into Europe from America, as the growing of potatoes and their year-round use became more and more common, scurvy became less common. Then in 1846 the potato crop of Ireland failed and in the subsequent winter a tragically severe epidemic of scurvy followed. Lind, in 1757, had assembled clear evidence that scurvy was prevented by "something contained in" the antiscorbutic food, and in 1847 Budd as quoted by Hess[1] definitely ascribed the action of antiscorbutic foods to "an essential element, which it is hardly too sanguine to state, will be discovered by organic chemistry or the experiments of physiologists in a not far distant future." According to the terminology of today Budd would have said "substance" rather than "element," and it cannot be questioned that he conceived of the antiscorbutic substance essentially as we now do. So far as the writer is aware, this statement by Budd in 1847 is the earliest in which the conception of a vitamin as an essential nutrient is so clearly set forth. In 1907, just sixty years after Budd's prediction, the Norwegian physician and hygienist, Holst, discussed the antiscorbutic substance on the basis of experimental evidence; and this was greatly extended and clarified by Holst and Frölich in 1912. At first this work did not attract the attention which it deserved, but a few years later when the World War had made scurvy again a prominent practical problem in western Europe, and when

[1] Hess, "Scurvy, Past and Present," Philadelphia, J. B. Lippincott Co., 1920, p. 173.

the conception of nutritionally essential substances previously unknown had been made familiar by the work with vitamins A and B, the evidence of the existence of a definite antiscorbutic substance came to be generally recognized and accepted, and this substance began to be known as vitamin C.

Like vitamin B, it is water- and alcohol-soluble and readily diffusible in its water solutions. It is not adsorbed with vitamin B by Lloyd's reagent; and there is no such bulk of evidence regarding the chemical nature of vitamin C as that which seems to assign vitamin B to the group of nitrogenous bases. Zilva,[2] who has given special attention to the concentration and attempted isolation of vitamin C, has found that a very high concentration may be obtained by removal of other materials in various ways and precipitation of the vitamin by means of basic lead acetate. Upon removing the lead from this precipitate "a very active fraction was obtained." "The chief chemical characteristic of the most potent fraction is that it contains very little nitrogen, traces of phosphorus, and that it decolorizes potassium permanganate and reduces ammoniacal silver nitrate in the cold. The last reaction was found so far by every active fraction. The reducing properties of active solutions cannot, however, be taken as criteria for their activity."

Inasmuch as reducing sugars and very likely other reducing substances are naturally present in the materials with which Zilva worked, it could not be expected that reducing properties of the fractions which he prepared should be due solely to the vitamin C which they contained. Even though the observations on this point are not conclusive, they appear to suggest that vitamin C may show the chemical behavior of a "reducing" substance, as we should expect in view of the fact that the antiscorbutic values of foods are rather readily diminished or destroyed by oxidation.

Drastic oxidizing agents such as potassium permanganate and hydrogen peroxide destroy vitamin C at an appreciable rate even at room temperature. Its destruction by atmospheric oxidation becomes rapid only on heating or on rendering alkaline the solution in which the vitamin C is contained. Doubtless the partial destruction of vitamin C which is to be expected when foods containing this vitamin are heated, is largely due to an oxidation reaction which proceeds more rapidly the higher the temperature, and which also is accelerated by diminishing the acidity or increasing the alkalinity of the medium. The simple statement that the vitamin is more stable in an acid than in an alkaline solution is true so far as it goes, but must not be allowed to give the impression that increased destruction begins only as the neutral point is passed. In experiments with tomato juice in which the p_H was shifted step by step from about p_H 4 to p_H 10, it was found that any diminution of the concentration of hydrogen

[2] Zilva, *J. Soc. Chem. Ind.*, **48**, 445–50T (1925).

ions and increase of concentration of hydroxyl ions increased the rate of destruction of vitamin C whether the particular hydrogen-ion concentrations involved were on the acid or the alkaline side of neutrality, and whether the change were such as to shift the p_H across the point of actual neutrality or not.

The juicy fruits and vegetables which constitute our main sources of vitamin C are more or less acid in reaction and, at the natural acidities of these foods and their juices, the vitamin is sufficiently stable to undergo ordinary cooking without losing more than moderate percentages of the antiscorbutic value of the raw food. The percentages of the original vitamin C thus lost are, however, very variable; and these variations depend upon a number of conditions. Among these conditions are the time and temperature of heating, the p_H (hydrogen-ion concentration or activity, "the reaction"), and the extent of exposure to the atmosphere or to oxygen or oxidizing substances. Kohman and Eddy consider that the amount of respiratory oxygen in the cells of apples is a relatively large factor in the destruction of vitamin C when apples are cooked or canned. They report that by covering peeled and quartered apples with a solution of salt in water, thereby retarding access of atmospheric oxygen and causing the consumption of the stored oxygen by the tissue respiration of the fruit, the subsequent heating could be carried on without appreciable loss of vitamin C. In many other foods, however, there are considerable losses which cannot be thus easily avoided. A factor which has only recently been studied,[3] but appears to be of much importance, is the natural oxidation potential of the fruit or vegetable juice in which the vitamin C is contained. Thus the higher oxidation potential of cabbage juice than of tomato juice appears most probably responsible for the fact that the former loses more of its antiscorbutic value than the latter when both are adjusted to the same reaction and heated at the same temperature for the same length of time.

In tomato juice the initial concentration of vitamin C is high, the oxidation potential is relatively low, and the high acidity is favorable to the stability of the vitamin and also makes possible the successful preservation of the food with relatively little heating at the time of canning. As the result of this combination of favorable conditions, canned tomato (now almost universally available) is one of the best of our antiscorbutics. But, as shown by experiments with acidulated cabbage juice, relatively high acidity does not always result in good preservation of the vitamin; nor is marked acidity always essential. The fact that Hess and also Hume have found the antiscorbutic value to be well preserved in sweetened condensed milk is evidence that vitamin C in a nearly neutral solution can be preserved

[3] La Mer, Kenny, and Sherman results reported at Philadelphia meeting, American Chemical Society.

through a moderate heat treatment and subsequent storage when both heating and exposure to air are reduced to a minimum by evaporating under vacuum and immediately placing the product in air-tight containers. Recent work has also shown a good conservation of vitamin C in the drying of milk—both by the "drum" or "roller" and by the "spray" processes.

In the foregoing, our ability to measure quantitatively the relative amounts of vitamin C in different foods, or in the same food after different treatments, has been implied; perhaps it should be more explicitly stated and explained.

By the use of guinea pigs as experimental animals it is possible to determine the relative amounts of vitamin C in foods by actual feeding tests in much the same general way that the relative amounts of vitamin B are found by means of feeding experiments with rats.

In both cases the general plan is to feed a standard test animal an unrestricted amount of a basal diet excellent in all other respects but devoid of the vitamin in question, and then ascertain just what daily allowance of the food under test will supply the minimum quota of the vitamin in question to produce a standard result in the standard test animal.

There is in one sense a distinct difference in that whereas we depend almost entirely upon the weight curve in vitamin B experiments with rats, in vitamin C experiments with guinea pigs the weight curve plays a part no greater than, if as great as, the observance of the presence or absence of scurvy symptoms and a judgment of their severity if present. Space does not permit a full description of the method here, nor a tabulation of the results obtained with different foods. These, as well as a fuller treatment of other topics touched upon in this paper, may be found, if desired, in Chapter XV of the writer's "Chemistry of Food and Nutrition," third edition, New York, The Macmillan Co., 1926.

But the reader may wonder why so much attention need be given to the relative amounts of vitamin C in foods and the differing efficiencies of conservation of this vitamin in the cooking, canning, and storage to which our foods may or may not be subjected, if the function of this vitamin is to prevent scurvy and if scurvy is no longer prevalent. There are strong reasons—both scientific and practical. From the scientific point of view any substance which is essential to life processes is deserving of thorough study if the ultimate aim of scientific research is to render intelligible the world in which we live—and thorough study necessitates the development and use of quantitative methods. And from the practical standpoint vitamin C is an important factor in food values whether we ever encounter a clear case of scurvy or not, partly because this vitamin not only protects against scurvy but plays an extremely significant rôle in normal nutrition as well, and partly because while well-marked or "mani-

fest" scurvy may seldom be seen, the occurrence of "latent scurvy" due to a less severe shortage of vitamin C may be much more common.

For both of these reasons, the absence of distinct signs of scurvy cannot be considered as proof that the food is supplying all the vitamin C that the body needs for its best condition.

Hess has repeatedly pointed out how frequently children, without showing any distinct scurvy symptoms, become irritable, flabby, and more or less retarded in growth, and can be restored to better growth, enhanced stamina, and better general health and disposition by the feeding of additional vitamin C in the form of any suitable food, showing that the previous food supply although adequate for the prevention of manifest scurvy had not been rich enough in vitamin C to ensure the best health and development of which the child was capable.

Plimmer emphasizes the view that among adults also there are many cases in which the food furnishes enough vitamin C to prevent acute scurvy but not enough for really good health. He points out that the experience of the World War showed that wounds healed more slowly among soldiers whose rations had been poor in vitamin C; and that in ordinary life, diets containing enough vitamin C to prevent scurvy but not enough for optimum nutrition are far too common and are reflected in "sallow, muddy complexion, loss of energy, fleeting pains in the joints and limbs, especially in the legs, usually mistaken for rheumatism." He also holds that much of the so-called rheumatism in infants and young children is really latent scurvy.

Furthermore it has been definitely shown by several investigators that a diet poor in vitamin C increases the susceptibility of the body to infectious diseases, and conversely that a liberal intake of this vitamin over and above the amount needed to prevent scurvy gives the body a higher degree of health as manifested in a greater power to resist infection. One of these investigators, Findlay, has concluded a recent article with the words: "The antiscorbutic vitamin has thus a double rôle to play in nutrition, for not only does it prevent scurvy, but its presence in sufficient amount in the diet is essential if the tissues are to resist successfully the attack of common microörganisms."

In addition to the books listed at the end of the first paper of this series Hess' "Scurvy: Past and Present" will be found of interest to those readers who wish to consult fuller accounts of scurvy and of vitamin C.

A selected list of original publications including several too recent to be included in the reference books already mentioned, may be found on pages 440 to 443 of the writer's "Chemistry of Food and Nutrition," third edition, 1926.

STUDENT PRECISION IN QUANTITATIVE ANALYSIS*
II. NUMERICAL LIMITS OF PRECISION FOR CERTAIN QUANTITATIVE METHODS

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In a preceding paper[1] the various factors which influence student precision in quantitative analysis were discussed. The purpose of this paper is to present the limits of precision to which the beginner using various elementary methods can justly be held. The method of grading quantitative laboratory determinations, recently set forth by Frost,[2] is based on two quantities which are numerically determinable by the instructor: (*a*) the difference between the duplicate results on a given sample; and (*b*) the difference between the student's average percentage and the correct percentage of the constituent. The scheme apparently assumes, however, that the limits of precision are the same for all methods; for it is made to apply equally well to the grading of such determinations as chlorine and silica, although the methods of determining these substances differ considerably in difficulty or newness of technic, or in chances of error. The writers are of the opinion that any system, to be entirely fair and reasonable, must take into account the limits of precision which the methods employed by the beginner involve. To arrive at a true measure of these limits, it has seemed more logical to study the numerical results actually obtained by students in the laboratory rather than to consider as a criterion for student attainment the precision of which a chemist with a thorough knowledge of theory and of years of experience might be capable.

In our work a careful record has been kept for several years of the duplicate results obtained by each student on the samples given him. For the purposes of this study, we have taken into account only the results of analyses graded as satisfactory or better. The determinations had in all cases been carried out according to Blasdale, "Principles of Quantitative Analysis," second edition, 1916, D. Van Nostrand Company. The number of determinations chosen to calculate the precision of each method was generally within the number required by the Law of Probability. The data[3] are assembled in Table I.

Discussion of Table

In Column A are listed the materials analyzed, which in all cases were either synthetic mixtures, naturally occurring rocks or minerals, or metal-

* A revision and expansion of a paper delivered before the Division of Chemical Education of the A. C. S. at Tulsa, April 6, 1926, under the title, "Limits of Student Precision in Elementary Quantitative Analysis."

[1] THIS JOURNAL, 3, 1271–6 (Nov., 1926).

[2] THIS JOURNAL, 3, 562–4 (May, 1926).

[3] The authors are indebted to Dr. P. H. M.-P. Brinton, formerly of this university and now of the University of Minnesota, for some of the data included in this table.

lurgical products. This choice made it impossible for the student to calculate the percentage of constituent in advance.

Column C gives the total number of good determinations made in each case. It may appear that the table includes only one, or two, or three different samples to illustrate the respective constituents. It is not intended to imply that only one, or two, or three samples were analyzed by the students. Our student samples, numbering about ten for each constituent, do not, as a rule, differ very greatly as to percentage of constituent. To conserve space, the writers have grouped the student samples according to percentage, the several numbers in Column C referring to such groups.

TABLE I. PRECISION IN STUDENT ANALYTICAL DETERMINATIONS

Column A	Col. B	Col. C	Col. D	Col. E	Col. F	Col. G	Col. H	Col. I	Col. J*
				Dev. between dupl.		Dev. from theor.			
Material	Constit. sought	No. detns.	Theor. %	Best	All	Best	All	Abs. % error (Best)	Equiv. departure
Gypsum	H_2O	31	19.6	..	..	0.08	0.13	0.40	0.10
	H_2O	11	5.8	..	..	0.06	0.06	1.04	0.13
Soluble Chloride	Cl	18	60.7	0.04	0.09	0.05	0.08	0.08	0.02
	Cl	10	47.6	0.08	0.10	0.05	0.08	0.11	0.02
	Cl	10	22.8	0.04	0.06	0.06	0.08	0.26	0.02
Sulfide Ore	S	56	9.9	0.06	0.13	0.18	0.31	1.82	0.24
	S	30	18.7	0.07	0.10	0.12	0.21	0.64	0.15
Silicate Rock	SiO_2	106	71.7	0.07	0.17	0.29	0.62	0.40	0.10
Limestone	Insol. Gangue	154	16.0	0.08	0.10	0.08	0.19	0.05	0.12
	R_2O_3	"	3.3	0.07	0.10	0.10	0.21	3.03	0.19
	CaO	"	41.4	0.13	0.19	0.25	0.63	0.60	0.19
	MgO	"	2.2	0.06	0.09	0.10	0.23	4.55	0.19
	CO_2	"	34.1	0.18	0.28	0.24	0.64	0.70	0.20
Brass	Sn	58	0.1	0.01	0.01	0.02	0.05	20.0	0.12
	Pb	"	0.3	0.02	0.03	0.02	0.05	6.7	0.12
	Cu	"	64.3	0.07	0.12	0.24	0.33	0.37	0.08
	Zn	"	35.2	0.07	0.12	0.18	0.34	0.51	0.14
Sol. Chloride	Cl	34	40.2	0.11	0.14	0.14	0.32	0.35	0.08
	Cl	54	26.3	0.06	0.17	0.05	0.10	0.19	0.05
Conc. H_2SO_4	H_2SO_4	98	94.5	0.09	0.15	0.22	0.61	0.23	0.00
Cast Iron	Fe(by $KMnO_4$)	80	91.5	0.06	0.22	0.27	0.54	0.30	0.01
Limestone	CaO	50	41.4	0.09	0.19	0.19	0.47	0.46	0.13
Iron Ore	Fe(by $K_2Cr_2O_7$)	96	57.2	0.08	0.14	0.17	0.28	0.30	0.05
Copper Matte	Cu	76	41.5	0.15	..	0.10	0.27	0.24	0.04

* $J = G - 0.1\left(\frac{D - 25}{25}\right)$

In Column D are given the (weighted) mean percentages of constituent in the groups of samples just mentioned, rounded off to tenths of a per cent. These percentages serve as a means of indicating magnitude rather than as an accurate basis of calculating percentage of error.

Columns E and F give the average deviations between duplicate de-

terminations. If the work was honestly done, these deviations should afford some indication of the student's care in carrying out an analysis and of his ability to reproduce his results. Since such data can, however, too easily be made to agree by deliberate falsification, it seems unwise to attach as much weight to these deviations, as Frost[2] has done in his system of grading.

The ultimate test of the student's mastery of the theory and technic of a method should be the closeness with which he is able to approach the correct percentage of the constituent sought. The average deviations between the student's results and the true or correct percentage are given in Columns G and H. To avoid any possible misunderstanding in regard to the relation of these deviations to the mean percentages of Column D, it may be stated that the deviations were calculated, *not with respect to the weighted mean percentages*, but with respect to the true percentage of constituent in each of the respective samples. The deviations here given are themselves arithmetical means, irrespective of sign.

The absolute percentages of error, Column I, are calculated by dividing the figures in Column G by those in Column D, and thus indicate the average percentage error which the best students may make. They should likewise be a measure of the maximum precision of which the methods employed in determining the constituents are capable in the hands of the novice. Unfortunately, however, this quantity is itself a variable depending upon the total percentage of constituent that is present in a given sample.

In order to arrive at some rational "limit of precision" the writers have endeavored to eliminate this variable by using, instead of the absolute percentage error (Column I), a quantity which we have chosen to call the "equivalent deviation" from the correct percentage. In this scheme the deviations in Column G are all referred to some arbitrarily chosen reference percentage, for example, 25%. This was deemed desirable because it reduces the deviations of results on samples varying from 0 to 100% of constituent to a more nearly uniform basis. The assumption in calculating these "equivalent deviations" is that for every 25% increase in total percentage of constituent above the reference percentage, an additional 0.1% departure be allowed, whereas below the reference percentage, a corresponding penalty be imposed. That this assumption is reasonable follows from the fact that a large sample of low-grade material would involve lesser percentage errors in weighing, etc., than a small sample of high-grade material. If a sample happened to contain 50% of constituent, the allowable deviation would then not be twice that on a 25% sample, but only 0.1% more than the deviation would have been had the total percentage of constituent been 25%. If the equivalent deviations are so calculated (see formula at foot of table) for each indi-

vidual case cited in the table, there should be reasonable constancy in the values obtained. Negative values of equivalent deviations sometimes found by this calculation obviously have no quantitative meaning. They have accordingly been reported as zero deviations. These equivalent deviations may be taken as a measure of the limit of precision of which a given method of analysis is capable. The same might, of course, be done for the data relating to all students, if an average value were desired. The results are given in Column J, and show very satisfactory constancy in the case of the volumetric and gravimetric chlorine determinations, and in the determination of sulfur. Other determinations not included in the table also gave very closely concordant equivalent deviations, even though the total percentage of constituent varied over wide limits.

Comparisons Made on Basis of the Table

The equivalent deviations so deduced offer a means of comparing methods of analysis as to "relative difficulty" for the beginner. All the methods referred to in the table might be grouped according to the magnitude of their equivalent deviations in intervals of 0.05%. Each group would then be found to have certain points in common, either as to number of steps, newness or difficulty of steps, or other chances or error. If the determination of sulfur in an ore, for example, in which the ferric hydroxide must be re-dissolved and re-precipitated as many times as the amount of iron present may require, be compared with a simple determination like that of chlorine, a considerable difference in their equivalent deviations would be expected; the table shows it to be 0.02% for Cl and 0.20% for sulfur. If the gravimetric, the permanganate, and the dichromate method, respectively, for iron be likewise compared, we find equivalent deviations as follows: 0.19%, 0.01%, and 0.05% which are consistent with the known sources of error in each method.

Conclusions

The question of precision is of paramount importance in all analytical work, and deserves more emphasis than it has hitherto received in most text-books of the subject. It seems only fair to the student that he be informed on the precision which different methods he uses will afford, and be encouraged to cultivate a critical attitude toward them. In the interest of inculcating in the minds of students a desire for the real truth as regards analytical results and of securing absolute honesty in quantitative work in all its aspects, it will always pay to play fair with the student so far as precision limits are concerned. It may well be recognized that much of the technic of quantitative analysis is entirely new to the student, and when precision is emphasized, he frequently fears the possibility of disaster in such degree that he is scarcely responsible for some of the mis-

takes he makes. The conscientious instructor will, in the interest of high standards of scholarship, endeavor to attain the best possible precision, but he will also recognize that there are limits which the student who carries out quantitative determinations for the first time cannot justly be required to exceed.

Permanent Paint for Iron Discovered by Swiss. The annual loss to the world due to the rusting of iron runs into many millions of dollars and the problem of its prevention is being studied by scientists in all civilized countries. Zinc, tin, nickel, ordinary lead paint and many other things are useful preventives, but they do not last and have to be re-applied more or less frequently.

A remarkable discovery is now announced from Switzerland. Dr. A. V. Blom, of Berne, has made a new lead paint which affords complete and permanent protection to iron. This paint is of a very special character: it is made by melting lead in an electric furnace and blowing through it air and certain reducing gases, so that a dross or scale is produced which consists of colloidal or extremely finely divided lead dispersed in yellow lead oxide. When it is powdered and mixed with a specially prepared linseed oil, and applied to an iron surface, very minute particles of lead separate out and gradually penetrate into the surface of the iron. The presence of the lead in the treated iron has been proved by photomicrographs and by chemical analysis. Iron objects painted with this new pigment have not shown any signs of rusting after prolonged exposure, or after being heated in steam. This discovery may lead to extremely important developments.—*Science Service*

Is Tobacco Injurious? "To smoke or not to smoke, that is the question." Sir Humphrey Rolleston of the medical faculty of Cambridge in a recent lecture before the Harrowgate Medical Society has summed up the existing evidence pro and con as to what tobacco actually does to one, with the conclusion that it is not so bad as many would have us believe.

There are several outstanding features, however, that are not so reassuring. Psychological tests show that smoking lowers mental efficiency from 10 to 23 per cent. While these results are not conclusive, said Sir Humphrey, it shows a definite lessening of capacity to work. It is also suggested that premature senility is induced in heavy smokers by the sedative action of nicotine on the nervous system.

Experimentally it produces definite degeneration of the arteries in rabbits but authorities believe that if tobacco smoking is really a cause in arteriosclerosis, it is a slow one, so mingled with the general conditions of old age that discrimination of the actual factors is almost impossible.

"The effect on the stomach," said Sir Humphrey, "is important; X-ray bismuth meals have shown that after a short period of increased contractility the motility of the stomach becomes paralyzed for an hour or so; as the subjective feeling of hunger very probably depends on contractions, the relief of hunger by smoking may thus be explained; it is said that dilation of the stomach may thus result."

Those who chew and take snuff may rest in peace. These practices are "attended by so little adsorption of nicotine as to be comparatively free from untoward symptoms."

Sir Humphrey is of the opinion that tobacco has ousted alcohol as a sedative and narcotic. There is little doubt, he thinks, that the injurious effects of smoking are materially augmented by, if they are not in part due to, simultaneous alcoholism.—*Science Service*

THE STRUCTURE OF MATTER: A BRIEF REVIEW OF PRESENT-DAY CONCEPTIONS. III. CHEMICAL COMBINATION

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As was indicated in Table II of the first paper[1] of this series, atoms may be divided into nine different classes, according to the charges on their kernels. Expressing the same idea somewhat differently, we can imagine all compounds to have been built up from hypothetical neutral atoms such as those diagrammatically represented in Fig. 2.

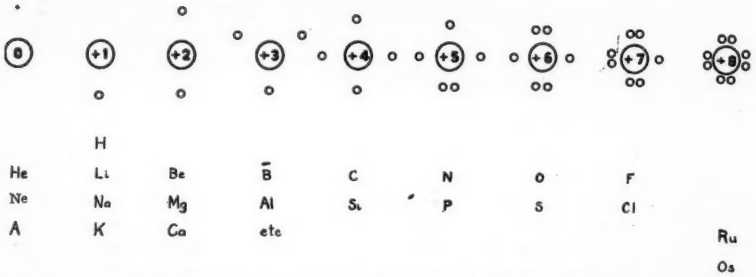


FIG. 2.—Illustrating the nine classes of neutral atoms, from which all compounds might theoretically be derived. The small circles represent valence electrons, outside of kernels having the net charges indicated.

Two Important Tendencies[2]

Of prime importance in considering combinations between atoms are two tendencies: (1) the tendency of the valence electrons to pair off, and (2) the tendency to form *octets*, *i. e.*, to add electrons to the valence shell until it contains eight, this tendency being, in general, greater the greater the kernel charge.

It should be emphasized that these are merely *tendencies*, for there are exceptions to both, as we shall see.

These tendencies are sometimes satisfied, in whole or in part, by the transfer of electrons from one atom to another, producing charged atoms or *ions*. Thus a sodium atom or a hydrogen atom may give up an electron to a chlorine atom.[3]

$$Na\cdot + \cdot\ddot{\underset{\cdot\cdot}{Cl}}: \longrightarrow Na^+ + :\ddot{\underset{\cdot\cdot}{Cl}}:^-$$

A pair of electrons can be shared between two atoms belonging to the valence shells of both at the same time. In sodium chloride or hydrogen

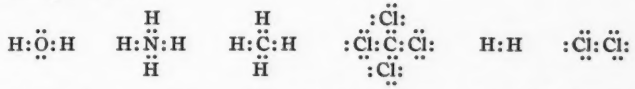
[1] THIS JOURNAL, 3, 1110–6 (Oct., 1926).

[2] Our present views of combination between atoms, as sketched in the following paragraphs, are due almost entirely to G. N. Lewis.

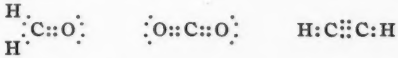
[3] The process is ordinarily not so simple as represented here, but the principle is the same.

chloride vapor the molecules probably have structures which can be represented as follows:

Other examples are:



Sometimes two or three pairs of electrons are shared between two atoms, where at least one of the atoms (usually both) so joined is carbon, nitrogen, or oxygen.[4]

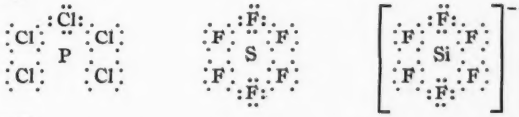


The atoms, other than hydrogen, in these compounds, as in the others mentioned above, have tetrahedral valence shells, being bonded together through tetrahedron corners, edges, or faces, according to whether the bonds are single, double, or triple.

A pair of electrons shared between two atoms is often held more tightly by one than by the other. We then say the bond is *semi-polar*. All degrees of polarity can exist, from *complete polarity*, where there has been a complete transfer of an electron from one atom to another, to *complete non-polarity*, where an electron pair (or two or three pairs, in double or triple bonds) is shared equally by the two atoms. The atom having the larger kernel charge usually holds onto a shared electron pair more tightly than the other atom. This polarity is of great importance in determining the chemical and physical properties of substances.

The formation of polyatomic ions from neutral elements involves both the transfer and the sharing of electrons. Thus the following groups of atoms all possess a negative charge due to the removal of one or more electrons from an electropositive atom or atoms, but the atoms within each group are held together by semi-polar bonds:

As exceptions to the "rule of eight" or the "octet rule" may be mentioned the following:



[4] Some chemists prefer to assume six-electron valence shells in these compounds with only single bonds, but in the writer's opinion the evidence is strongly against such an idea.

Other examples will be given among the "secondary valence compounds."

A few molecules contain an odd number of valence electrons. These must be exceptions to the "rule of two"—the tendency of the valence electrons to form pairs. NO, NO_2, ClO_2, and $(C_6H_5)_3C$ are examples of such "odd molecules." The arrangements of valence electrons in these substances are still in the field of speculation.

Secondary Valence[5]

Most of the compounds containing non-polar or semi-polar bonds whose structures have been illustrated above can be synthesized *on paper* from the hypothetical neutral atoms (Fig. 2) by reactions in which one electron of each bonding pair comes from each of the two atoms joined by that pair:

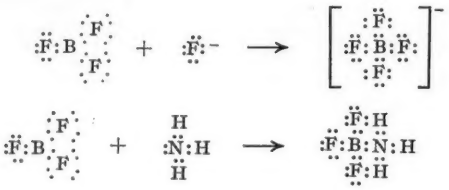
$$A\cdot + \cdot B \longrightarrow A : B$$

To obtain any of the poly-atomic ions illustrated, however, one must postulate reactions in which both electrons of one or more bonding pairs come from the same atom:

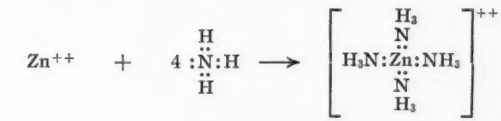
$$A + :B \longrightarrow A : B$$

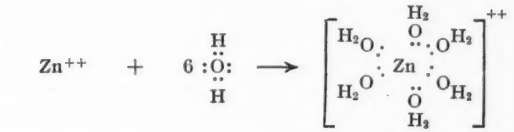
Although such reactions are quite as reasonable as those of the other kind, old-fashioned valence theory does not take them into account. In fact, *whenever either reactions of the second type or a complete transfer of one or more electrons from atom to atom (ionization) must be assumed, the structural formulas as ordinarily written do not correctly represent the actual structures.* Where there is ionization, at least one of the "bonds" in the structural formula must be considered to represent not an actual bond, but a positive charge on one atom or group of atoms and a negative charge on another.

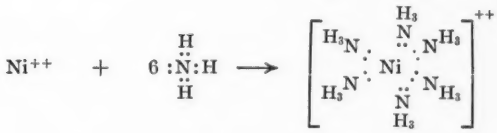
The whole problem of the nature of "secondary valence" is now solved. "Secondary valence compounds" are those which cannot be thought of as having been formed from neutral atoms entirely by reactions of the first kind. Once formed, the bonds formed by the two types of reaction are identical. These statements may be illustrated by a few examples of "secondary valence *reactions*:"

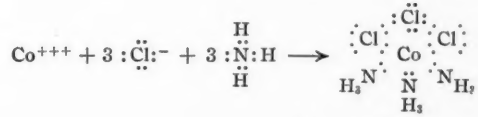


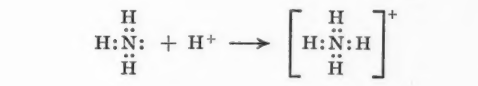
[5] Huggins, *J. Phys. Chem.*, **26**, 601 (1922).

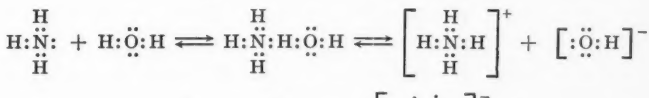


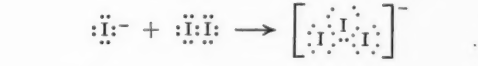


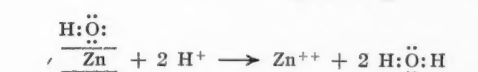


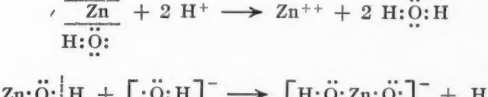












It will be noted that in a number of the foregoing compounds an atom has more than four electron pairs in its valence shell. This is fairly common among the more electro-positive atoms but is relatively rare among the more electro-negative atoms.

NOTES ON THE ELECTRON METHOD OF TEACHING OXIDATION AND REDUCTION

L. J. WALDBAUER AND W. E. THRUN, LEHIGH UNIVERSITY, BETHLEHEM, PA.

The use of the electron concept in teaching the nature of oxidation and reduction, and in the balancing of equations is the only rational scheme. The old-fashioned step equation method involves absurdities and unwarranted assumptions, while the positive and negative valence method, though algebraically efficient, does not present a clear view of the nature of oxidation and reduction. Professor Brinkley[1] has presented the electronic conception in a manner that must please those desirous of giving a fundamentally correct idea of the subject to their classes. The writers have used a method similar to Professor Brinkley's in their elementary classes, and offer the following ideas as a supplement to his admirable outline.

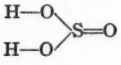
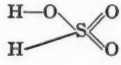
Before discussing the method of balancing equations, we have found it of advantage to give type compounds for every possible state of oxidation of an atom, *e. g.*, nitrogen.

Gained 3ϵ	Gained 2ϵ	Gained 2ϵ Lost 1ϵ Net gain 1ϵ	Neither gained nor lost ϵ	
NH_3	NH_2NH_2	NH_2OH	N_2	
Lost 1ϵ	Lost 2ϵ	Lost 3ϵ	Lost 4ϵ	Lost 5ϵ
N_2O (HNO)	NO	N_2O_3 HNO_2	NO_2	N_2O_5 HNO_3

B. Carbon

Gained 4ϵ	Gained 3ϵ Lost 1ϵ Net gain 2ϵ	Gained 2ϵ Lost 2ϵ Net —	Gained 1ϵ Lost 3ϵ Net loss 2ϵ	
CH_4	CH_3OH			
		Neither gained nor lost	Lost 2ϵ	Lost 4ϵ
		C	CO	CO_2

C. Sulfur

Gained 2ϵ	Neither gained nor lost	Lost 2ϵ	Lost 4ϵ	Lost 6ϵ
H_2S	S	SO	SO_2	SO_3
		Gained 2ϵ Lost 4ϵ Net loss 2ϵ	Gained 1ϵ Lost 5ϵ Net loss 4ϵ	
				

From this it may be seen that atomic carbon represents the same state of oxidation as is found in the carbon of formaldehyde, while CO represents

[1] THIS JOURNAL, 2, 576–87 (1925).

the same state of oxidation as the carbon of formic acid. These facts are ordinarily not apparent.

Balancing Equations

We do not believe in the necessity of burdening students with a complicated system of balancing equations, such as that proposed by Griggs and Warner.[2] For the special cases, such as Na_2O_2 and Na_2S_2 oxidations, we use the following simple explanation:

The Na_2O_2 molecule (or the Na_2S_2 molecule) *as a whole* can take up two electrons, which is a fact requiring no assumptions.

$$\underset{\text{Cr has lost } 3\epsilon}{NaCrO_2} + Na_2O_2 = \underset{\text{Cr has lost } 6\epsilon}{Na_2CrO_4}$$

Na_2O_2 can take up 2ϵ. The least common multiple of 2 and 3 is 6, and therefore

$$2NaCrO_2 + 3Na_2O_2 + 2H_2O = 2Na_2CrO_4 + 4NaOH$$

Water may be used on either side of the equations to balance them.

The reaction between $KMnO_4$ and HCl also presents some difficulties.

$KMnO_4 + HCl + HCl = Cl_2 + KCl + MnCl_2$.
Mn gains 5ϵ in going from $KMnO_4$ to $MnCl_2$.
Cl loses 1ϵ in going from HCl to Cl_2.
The L.C.M. is 5, but since chlorine is molecular, 10 must be used.
Therefore, 10 HCl molecules are oxidized and $2KMnO_4$ molecules must be reduced.

$$2KMnO_4 + 10HCl + 6HCl = 5Cl_2 + 2MnCl_2 + 2KCl + 8H_2O.$$

Obviously 6 HCl molecules are required to furnish anions for the K and Mn.

Balancing Equations Involving Compounds in Which One Kind of Atom Exists in Different States of Oxidation

$$HNO_3 + Fe_3O_4 = NO + Fe(NO_3)_3.$$

In Fe_3O_4, the Fe atoms have lost 8 electrons; the 3 Fe atoms can lose a maximum of 9ϵ. Therefore, one Fe_3O_4 molecule can lose one electron. The N in HNO_3 has lost 5ϵ, while that in NO has lost 2ϵ; therefore, there has been a net gain of 3 in going from HNO_3 to NO, and we can write:

$$HNO_3 + 3Fe_3O_4 + 27HNO_3 = NO + 9Fe(NO_3)_3 + 28H_2O.$$

The 27 molecules of HNO_3 are required to furnish anions for the Fe.

$$Na_2S_2O_3 + I_2 = NaI + Na_2S_4O_6.$$

Each iodine atom can gain an electron, and in sodium iodide this has taken place. Two molecules of sodium thiosulfate can lose two electrons. Hence we can write:

$$2Na_2S_2O_3 + I_2 = 2\,NaI + Na_2S_4O_6.$$

The old-fashioned structural formulas are frequently of great assistance in showing the electronic changes.

[2] THIS JOURNAL, 3, 425–31 (1926).

A VALENCE-NAME-FORMULA-SOLUBILITY CHART

G. N. QUAM, COE COLLEGE, CEDAR RAPIDS, IOWA

The author of every elementary text-book of general chemistry endeavors to present the need and usefulness of symbols and formulas very early in the course in a way that will make it easier for the student to retain a reasonable working knowledge of the subject. Every teacher, however, realizes that the student is confronted with a new means of expression and requires considerable drill in order to acquire the working knowledge desired. As helps in the study of formula writing, short lists of common negative and positive radicals are to be found in some texts, and tables of principal valences of elements in some hand-books. A name and formula chart, patented by C. D. Poore (1905), contains the more common negative and positive radicals grouped separately in order of valence. The writer has found the use of a modification of this chart very helpful in his classes in general chemistry.

Solubility tables found in texts and hand-books are of two general types: those giving numerical values and those giving relative solubility by use of symbols. The former and more useful type are found in such text-books of general chemistry and qualitative analysis as those by Deming, Test and McLaughlin, Schlesinger and Holmes. The chart described herewith has resulted from the writer's effort to help students acquire more quickly not only a working knowledge of valence and formula writing but also a more definite familiarity with both relative and numerical solubility values of the more common compounds.

The numerical solubility values have been taken from a number of sources. The nature of the chart would not permit reference directly nor by key. Of the more elaborate sources, Seidell's Solubilities of Inorganic and Organic Substances, was used; hand-books of recent edition to which reference was made include Van Nostrand's Chemical Annual, The Hand-Book of Chemistry and Physics published by the Chemical Rubber company, The Chemists' Year Book edited by Atack; and tables contained in the following texts were consulted for additional data or used for the purpose of checking: General Chemistry by Holmes, General Chemistry by Deming, General Chemistry by Schlesinger, and Notes on Qualitative Analysis by Test and McLaughlin.

The relative solubilities in the Valence-Name-Formula-Solubility chart are indicated by half or full bars near the upper or lower edges of the rectangles representing compounds. Where numerical data were not found the symbols used in certain tables were translated into the form used here. Such tables are to be found in Analytical Chemistry, Volume I, by Treadwell and Hall, the Van Nostrand Chemical Annual, and the Hand-Book of Chemistry and Physics.

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VALENCE — NAME — FORMULA — SOLUBILITY CHART

Negative radicals → / Positive radicals ↓		Hydroxide $OH^{'}$	Fluoride $F^{'}$	Chloride $Cl^{'}$	Bromide $Br^{'}$	Iodide $I^{'}$	Cyanide $CN^{'}$	Nitrite $NO_2^{'}$	Nitrate $NO_3^{'}$	Acetate $C_2H_3O_2^{'}$	Chlorate $ClO_3^{'}$	Permanganate $MnO_4^{'}$	Thiocyanate $CNS^{'}$	Bicarbonate $HCO_3^{'}$	Bisulfate $HSO_4^{'}$	Oxide $O^{''}$	Sulfide $S^{''}$	Sulfite $SO_3^{''}$	Sulfate $SO_4^{''}$	Thiosulfate $S_2O_3^{''}$	Carbonate $CO_3^{''}$	Chromate $CrO_4^{''}$	Bichromate $Cr_2O_7^{''}$	Silicate $SiO_3^{''}$	Oxalate $C_2O_4^{''}$	Tartrate $C_4H_4O_6^{''}$	Biborate $B_4O_7^{''}$	Chlorplatinate $PtCl_6^{''}$	Phosphate $PO_4^{'''}$	Arsenite $AsO_3^{'''}$	Arsenate $AsO_4^{'''}$	Ferrocyanide $Fe(CN)_6^{''''}$	Cobalti nitrite $Co(NO_2)_6^{'''}$	Borate $BO_3^{'''}$	Ferrocyanide $Fe(CN)_6^{''''}$	
Hydrogen	H^{+}			73.41	204.0																															1
Lithium	Li^{+}	12.8	2.7×10^{-3}	77.0	174.0	165.0		48.9	70.3	300.0	213.5	71.4		3.5		5.2			34.3		1.35	110.9			6.24					4.0×10^{-2}							2
Sodium	Na^{+}	107.5	4.4	35.9	89.0	176.7		73.5	86.0	47.0	97.0			9.6			15.3	25.31	16.8	69.0	19.5	77.5	178.0		3.5	39.7	2.52		19.6		10.4	29.7		7.8	17.9	3
Potassium	K^{+}	110.0	92.5	33.4	64.1	142.6		74.5	29.6	245.0	6.7	6.34	209.2	24.9	30.2			100.0	10.73		111.5	62.8	11.0		37.7	139.0	26.7	11.0×10^{-4}			18.87	41.0	9.0×10^{-3}		36.8	4
Ammonium	NH_4^{+}			36.4	73.5	178.3		MX	200.0			8.0	142.4	21.0					78.0		100	MX	29.0	30.0	4.2	5.9		6.7×10^{-4}	25.0		M	MX			MX	5
Cuprous	Cu^{+}			1.2		5.0×10^{-8}							5.0×10^{-8}									2														6
Silver	Ag^{+}	2.2×10^{-3}	185.0	1.5×10^{-4}	1.1×10^{-6}	3.5×10^{-7}	4.5×10^{-6}	3.3	204.0	1.005	12.25	1.27	1.4×10^{-5}			2.1×10^{-3}	1.36×10^{-3}		8.0×10⁻²		3.0×10^{-3}	2.5×10^{-3}	8.3×10^{-3}		3.5×10^{-2}	2.0×10^{-1}			6.5×10^{-4}	1.15×10^{-3}	8.5×10^{-5}	6.8×10^{-5}				7
Mercurous	Hg^{+}			5.0×10^{-3}	3.9×10^{-6}	2.0×10^{-8}				7.5×10^{-4}									6.0×10^{-5}																		8
Thallous	Tl^{+}	40.0	72.5	3.6×10^{-4}	4.8×10^{-3}	6.4×10^{-3}			8.91		3.69		3.2×10^{-4}						4.74		4.95	6.0×10^{-3}			1.48			6.4×10^{-3}	5.0×10^{-4}								9
Magnesium	Mg^{++}	1.2×10^{-3}	7.6×10^{-3}	54.1	96.1	148.0			73.2		130.0					6.2×10^{-6}		1.0	34.6		1.0×10^{-2}	72.3			3.0×10^{-2}				3.05×10^{-3}							10
Calcium	Ca^{++}	1.67×10^{-2}	1.6×10^{-3}	72.5	141.0	203.0			121.2	35.0	177.8	359.0							2.0×10^{-1}		1.5×10^{-3}	2.0×10^{-1}			5.6×10^{-5}											11
Strontium	Sr^{++}	7.8×10^{-2}	2.5×10^{-3}	52.8	98.0	176.0			67.6	40.7	175.0							3.3×10^{-2}	1.1×10^{-2}		1.0×10^{-3}	4.2×10^{-2}			4.5×10^{-5}											12
Barium	Ba^{++}	3.58	1.6×10^{-2}	35.2	103.0	195.0	80.0		8.8	69.1	35.5	73.4							2.3×10^{-4}		2.2×10^{-3}	3.8×10^{-2}			8.9×10^{-5}						5.5×10^{-2}				1.0×10^{-7}	13
Cupric	Cu^{++}			75.6					120.0	7.2	164.0		2.3×10^{-2}				3.3×10^{-5}		20.0						7.5×10^{-3}	4.2×10^{-3}										14
Zinc	Zn^{++}	5.6×10^{-4}	1.6	362.0	441.0	432.0			115.1	42.0	198.8					1.0×10^{-2}	6.9×10^{-4}	1.6×10^{-2}	53.0		1.0×10^{-3}				6.4×10^{-4}	2.2×10^{-3}										15
Cadmium	Cd^{++}	2.5×10^{-4}	4.36	140.0	100.0				185.0								1.3×10^{-4}								3.3×10^{-3}											16
Mercuric	Hg^{++}			7.39	4.0×10^{-2}	8.0×10^{-3}	1.1×10^{-7}	MX	2	3.3						5.1×10^{-3}	1.25×10^{-6}				M	X									M	MX		MX		17
Stannous	Sn^{++}			210.0		318×10⁻⁷											2.0×10^{-6}		18.9											3	2		2		18
Lead	Pb^{++}	1.55×10^{-4}	6.41×10^{-3}	9.14×10^{-3}	8.04	6.8×10^{-9}			30.7	30.0	151.3		5.0×10^{-7}			1.7×10^{-2}	8.6×10^{-5}		4.2×10^{-3}		1.1×10^{-4}	2.0×10^{-3}			1.5×10^{-4}				1.64×10^{-5}							19
Chromous	Cr^{++}																																			20
Manganous	Mn^{++}	2.1×10^{-3}		73.9		149.3			57.33	3.0							6.2×10^{-4}		61.16		1.3×10^{-3}				5.0×10^{-3}											21
Ferrous	Fe^{++}	6.7×10^{-6}		41.5	53.5				46.5								6.15×10^{-6}		26.4			2.2×10^{-4}			7.2×10^{-2}											22
Cobaltous	Co^{++}		2.32	50.0	10.3				45.47								3.8×10^{-2}		35.5																	23
Nickelous	Ni^{++}			39.1	120.8	196.2			50.0	18.1	56.74						3.6×10^{-6}		35.8																	24
Aluminum	Al^{+++}			400.0															36.1																	25
Arsenous	As^{+++}					6.0										1.77	5.2×10^{-3}																			26
Antimony	Sb^{+++}		395.9	872.5												1.82×10^{-3}	4.7×10^{-6}																			27
Bismuth	Bi^{+++}							MX	3								1.8×10^{-5}					M	X							M	MX		MX		28
Chromic	Cr^{+++}																		120.0			2	3													29
Ferric	Fe^{+++}			89.8						7.5×10^{-3}																											30
Cobaltic	Co^{+++}																																			31
Stannic	Sn^{++++}							M	X	4							2.0×10^{-5}				M	X	2								M	X	4	MX		32
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	

Type formula M_3X_2 as $Ca_3(PO_4)_2$. Solubility in gm/100gm H_2O at 18°C. Sol. in H_2O ☐. Sparingly sol. in H_2O ☐. Insol. in H_2O but sol. in Acid ☐. Insol. in Strong Acids ☐. Decompases in H_2O or Unknown ☐.

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The negative radicals are arranged at the top of the chart in groups in order of increasing valence while the positive radicals are arranged in a vertical column at the left edge in the same order. The attempt has been made to keep the radicals in the order in which the elements appear in the periodic table as nearly as such an arrangement would permit and the valence of each is indicated by plus or minus signs in order that the student will be reminded of valence by groups and individually. It is apparent that each rectangle formed by the cutting of the horizontal lines for the positive radical and the vertical lines for the negative radical represents a possible compound and further, that the sections of small rectangles formed by the cutting of lines representing like valence for the positive and negative radicals, respectively, can be represented by a type formula. If we let M represent the positive radical and X the negative radical, MX is the type formula of any compound formed by a monovalent positive radical and a monovalent negative radical such as NaCl. M_2X_3 may represent a compound like $Fe_2(SO_4)_3$ and so on. A student can, therefore, by noting the type formulas, write the correct formula of any compound possible by combining any of the 32 positive radicals with any of the 34 negative radicals.

The key at the lower edge of the chart indicates what each character represents. By observing the position of the full and half bars the student can quickly learn what compounds having a common positive radical or what compounds having a common negative radical are soluble in water, sparingly soluble in water, etc. For example: insoluble salts of potassium are K_2PtCl_6 and $K_3Co(NO_2)_6$; insoluble chlorides are AgCl, HgCl, TlCl, $PbCl_2$. The numerical data afford an opportunity for closer study of solubilities of groups of compounds and can also be used in the solution of problems where solubility data is required. As an illustration it will be noted that the order of decreasing solubility of the halides of silver is in the order of increasing atomic weight of the halogens. Blank spaces warn the student that the compound represented is either unknown or that it decomposes readily in water.

Like any other orderly grouping of chemical compounds the chart invites closer study of the physical and chemical properties of the related compounds. The chart is not planned to include all the radicals used in general chemistry courses but the attempt has been made to include the more common ones. The only excuse for presenting the chart in its present form is that the writer is satisfied that it has served a useful purpose in his classes.

Prof. Lyman J. Wood whose article on "Laboratory Reports in Beginning Chemistry" appeared in the November number of THIS JOURNAL, pages 1313–20, is now at the St. Louis University School of Medicine, St. Louis, Mo., instead of Defiance College, Defiance, Ohio.

AN EXPERIMENT SUITABLE FOR THE DEMONSTRATION OF THE PREPARATION AND PROPERTIES OF OXYGEN AND OF ENZYME ACTION (CATALASE)

H. L. WIKOFF AND J. B. BROWN, COLLEGE OF MEDICINE, OHIO STATE UNIVERSITY, COLUMBUS, OHIO

The usual laboratory method for the preparation of oxygen consists in the decomposition of potassium chlorate by heat, under the catalytic influence of manganese dioxide. This procedure necessitates the devising and setting up of apparatus and involves certain precautions. As a rule the beginner devotes more time to these considerations than to the study of the properties and reactions of oxygen. Another important method for preparing this gas is by electrolysis of water. The apparatus in this instance is too expensive to be used other than for a lecture demonstration.

It occurred to us that a more simple method for the laboratory preparation of oxygen might be based on the catalytic decomposition of hydrogen peroxide. This may be brought about very readily by one of the class of biological catalysts or enzymes called catalase. This substance, which is found in most tissues, occurs to an especially great extent in ordinary compressed bakers' yeast. Thus, for example, when yeast is added to H_2O_2 a vigorous evolution of oxygen takes place. The gas thus obtained can be readily used for any experiments in the study of its properties. The chemical reaction which is involved is as follows:

$$2H_2O_2 = 2H_2O + O_2$$

Theoretically from one volume of three per cent hydrogen peroxide ten volumes of oxygen should result, but practically the yield is less.

Directions for the Experiment

Mix a cake of compressed yeast* in a beaker with 200 cc. of water and stir until a uniform suspension results. Add to this mixture 200 cc. of 3 per cent hydrogen peroxide in a 500-cc. flask. After mixing, the flask is filled level full with water, a watch glass placed over the top and the whole quickly inverted over water. A vigorous evolution of oxygen immediately occurs which expels the reaction mixture from the flask. In five to ten minutes the flask is nearly full of oxygen. It can be covered with the watch glass and removed from the water. The gas is now ready for any further experiments desired.

It is to be observed that a considerable excess of peroxide is used, for the sake of simplicity of apparatus, since the reaction mixture is being expelled from the flask as the reaction proceeds. Should the instructor

* We are indebted to the Fleischmann Company for supplies of yeast for use in these experiments.

so desire, he may advise the use of other more complex apparatus so that all of the oxygen liberated may be collected. With slight variations in the apparatus including the use of a gas burette, the experiment may be adapted to a quantitative study of the rate of liberation of oxygen.

Water May Save Waste in Concrete, Says Expert. Waterproofing concrete with water is the possibility pointed out by Cloyd M. Chapman, chairman of committee on concrete of the American Society for Testing Materials. "By regulating the amount of water a more water-tight concrete may be made than if too much or too little water is used," Mr. Chapman explained. "The same is true of durabliity and wearing qualities. Any owner, engineer, architect, or contractor who neglects this factor is not getting the most for his money in concrete."

It is the common notion that the strength of concrete is entirely dependent upon the amount of cement in it; that to make stronger concrete more cement must be added. This is not true. The cheapest ingredient in concrete is the one that really controls its strength. A sloppy concrete mixture will make about half as strong a concrete after it sets and hardens as will exactly the same concrete mixture with one-fourth less water. An extra gallon of water added to a one-bag-batch of concrete is about equivalent to taking out of the mixture fifteen pounds of cement and throwing it away, so far as the strength of the concrete is concerned.

A one-two-four mix is commonly considered "good concrete." So it may be, if the materials are all of good quality and about six gallons of water are used for each bag of cement. The resulting concrete, if properly handled, will have a crushing strength of about 3000 lbs. at the age of a month, and probably 4000 lbs. or more in a year. But for every pint of water used in excess of the six gallons the strength at the end of a month will be reduced about 100 lbs. If eight gallons of water are used, instead of the six, the strength would be only about 1500 lbs. per square inch. To repair the damage done by those two extra gallons of water it would be necessary to add about one-third more cement. With cement selling at more than $2.00 a barrel, it becomes rather expensive to neglect to take those facts into account.—*Science Service*

New Antiseptic Is One of Most Powerful Known. A mercury compound first made several years ago has proved after further tests to be unusually destructive to some of the most dangerous germs. Prof. George W. Raiziss of the University of Pennsylvania at the meeting of the American Chemical Society said that this substance, known as metaphen, is 47 times more powerful than bichloride of mercury, 258 times more effective than mercurochrome and 4300 times as destructive as carbolic acid to the deadly anthrax bacillus.

When the virulent type of streptococcus germ which causes deadly blood-poisoning in man is put in a solution of metaphen diluted over three million times it is completely destroyed in four days. The effect of the substance on the pneumonia germ is just as striking, for it is over a thousand times more effective than carbolic acid for that purpose.

Metaphen is poisonous to a considerable extent when injected into the veins, Prof. Raiziss said, though not so much so as bichloride of mercury. It can, however, be injected into the muscles in quite large doses. Laboratory animals can tolerate surprisingly large doses of the substance when given by the mouth. Metaphen is useful in operations, Prof. Raiziss said, both for preparing the operative field and for sterilizing the instruments, and the wounds afterwards. It has been administered intravenously in cases of human blood-poisoning, saving the patient's life in a number of instances.—*Science Service*

CLEVELAND REGIONAL MEETING OF THE AMERICAN CHEMICAL SOCIETY

The fifth meeting of the Cleveland region of the American Chemical Society was held in Cincinnati on October 22nd and 23rd with the Cincinnati Section as the host.

The Friday forenoon and afternoon sessions were held in the main lecture room of the Chemistry Building at the University of Cincinnati. The Departments of Chemistry and Chemical Engineering there are to be congratulated, not only upon having a very excellent hall, but also for the inestimable work done in the preservation of the history of chemistry as displayed in the chemical library and the old cuts in the corridors. At the head of the main entrance to the building is a gift from a group of chemistry students, which consists of a fountain with an emblematic and symbolic background. Entirely aside from the standpoint of general design, material used, and color scheme, this fountain is truly a piece of art for it invites more than a mere glance by its careful and complete depiction of some of the early and fundamental scientific achievements now embodied in this great field of chemistry.

Dr. A. O. Snoddy, Chairman of the Cincinnati Section, was the agreeable and efficient presiding officer of the occasion. The meeting was opened by a presentation of the results of a comparison of the "Lecture Demonstration vs. Individual Laboratory Work for Beginners in Chemistry" by Professors R. N. Maxson and V. F. Payne. The research is still in the early stages and their final conclusions will be anticipated with considerable interest. Professor J. E. Day informed the assembly in a qualitative way about the promoter action of certain salts, particularly the chlorides on the rate of the precipitation of Cu from aqueous $CuSO_4$ solutions by means of Al.

Professor B. S. Hopkins gave the history of the extensive work by himself and his students in the discovery of element 61 (Illinium). Thus far, the presence of the element has been determined by spectral studies, particularly the Moseley number. Professor Hopkins is now reaping the scholarly reward of a large number of years devoted to the patient quest for this formerly unknown element.

"The Significance of the Occurrence of Manganese, Copper, Zinc, Nickel, and Cobalt in Kentucky Blue Grass" was presented by Dr. J. M. McHargue. It was somewhat of a surprise to part of the audience that these heavy metals were found to such an extent in the grass under study. Professor J. R. Withrow reviewed the current theories of petroleum formation and the work which is now being done by C. B. Morrey on the formation of the saturated hydrocarbons from certain vegetable products in the presence of bacteria. He also commented on the differences in the reports as to the petroleum supply as given by geologists and petroleum chemists. He

pointed out that even if the end of our oil resources is not in sight, we should practice conservation and that pressure catalysis on CO and H_2 will doubtless in the future give us a sound chemical basis for liquid fuel production.

President F. C. Hicks, of the University of Cincinnati, welcomed the chemists to the campus and subsequently gave a short account of the origin and growth of the University. Dean Herman Schneider, of the College of Engineering, told the audience of his dream of coöperative research and how it was being realized in one of his laboratories in making a study of "The Relation of the Quantum Theory to Biology." The first results are already in print (University of Cincinnati Institute of Industrial Research, Series 4, Paper 1, Apr. 2, 1926). The foreword, in particular, will be of interest to all engaged in scientific investigation.

Dr. G. Davis Buckner gave an interesting account on "The Relation of Calcium to the Hatchability of Eggs." His results show that gypsum and dolomitic calcium carbonate do not show as good results as the non-dolomitic carbonate in giving a high percentage hatch. Dr. W. J. Kelly presented the latest work of his laboratory on "The Structure of Rubber," showing the relation of rubber proteins to latex emulsion and coagulate and the influence of p_H on these relationships and the properties of the resulting rubber.

Professor R. A. Kehoe ("Some Factors Influencing the Distribution of Lead in the Animal Organism") showed the statistical facts gathered in a lengthy study of lead distribution in the animal system (rabbits) when the lead was derived from various sources—a potentially important basis for treatment and prevention of lead poisoning.

Professor Withrow read Dr. A. E. McGee's paper on "The Preparation of a Decolorizing Carbon from Lignite," showing how a highly absorbent carbon can be obtained from this source by intelligent application of fundamental principles just as done by early workers, the technic of whom had been overlooked.

Professor O. J. Stewart exhaustively discussed the periodic system in the light of modern atomistic ideas.

The Executive Committee of the Regional Group had a short session at which the following items came up for consideration: (1) It was voted that the next annual meeting be held in Erie, Pa., and the one following in Lexington, Ky. (2) The resignation of Secretary W. J. Kelly was accepted and H. A. Shonle was chosen as his successor. (3) The difficulty experienced in getting suitable papers was related and it was recommended that: (*a*) The Secretary of each of the sections immediately begin a campaign for presentations at the Erie Meeting; and (*b*) as each section will eventually be host to the Regional Meeting, there need be no hesitancy about scheduling a majority of the program from the enter-

taining membership. (4) The arrangement of the programs of certain intersectional speakers was discussed. (5) It was suggested that the entertaining section make its first announcement of the date of the meeting at least seven or eight weeks in advance.

A dinner in honor of Professor and Mrs. Ernst Cohen was given at the Hotel Sinton in the evening. Dr. Snoddy presented Professor A. P. Mathews as the toastmaster, who, in turn, introduced the speaker of the evening. Professor Cohen in his delightful way gave us a praise-worthy fragment of his well-known hobby on "Caricature in Science." About 120 were present for the evening program.

On Saturday the assembly broke up into smaller parties and enjoyed trips to the Rookwood Pottery, the Procter and Gamble Company, the U. S. Cast Iron Pipe and Foundry Company, the Columbia Power Company, the tomb of William Henry Harrison, and The Fernbank Dam.

The meeting was a pronounced success. On to Erie and Lexington!

J. E. DAY
J. R. WITHROW

Metal Objects Now Made by Electricity. The manufacture of metal tubes and sheets by electricity which has always been the fascinating dream of the inventor, is at last beginning to be a reality, Dr. William Blum, electro-chemist of the U. S. Bureau of Standards, explained to members of the American Chemical Society. Until recently the project has attracted large investments and yielded few returns, but now copper sheets and iron tubes are being made successfully on a commercial scale in the United States. Whether or not the processes will survive competition it is yet too early to tell, Dr. Blum said.

The attraction in this way of making metal shapes lies in the fact that the most complicated forms are apparently easy to make, and unlike the rolling and drawing processes, the thinner walled ones are cheaper to make than the heavy ones. The method has developed slowly because it is hard to get impervious deposits and uniform distribution of metal of suitable structure and quality. These difficulties can be overcome, Dr. Blum believes, by careful research and scrupulous control of operating conditions. One of the most important requirements is to keep the solution of the metal that is to be deposited in the shape desired, free from suspended matter and other impurities.—*Science Service*

Sun Injures Silk but Dry Cleaning Does Not. The silk dress milady has just bought this fall will probably last longer than the one she wore during the sunny afternoons this summer.

The wearing qualities of silk are greatly lessened by exposure to sunlight, it has been learned from tests recently completed at the U. S. Bureau of Standards. The strength of unweighted dyed silk decreased 25 per cent, it was found, when exposed to sunlight for 100 hours. Silk of cheaper grade that had been weighted with metal to give it a rich shimmering appearance lost as much as from 50 to 75 per cent in general tensile strength.

The silk garment that hangs in the closet or reclines in a bureau drawer is safe, apparently, for the tests showed that silk kept in storage for two and a half months gave no signs of deterioration. No harmful results were found, either, from the action of dry-cleaning solvents on different silk fabrics.—*Science Service*

Chemical Digest

SCIENCE IN PRACTICAL AFFAIRS

The organization of American Anode, Inc., by the B. F. Goodrich Co., the Eastman Kodak Co., and the Anode Rubber Co., Ltd., of Great Britain, has been announced. This new organization has for its purpose the development of commercial production in the United States of rubber goods manufactured under the Klein and Eastman process patents. The processes covered by these patents are the result of the work of Dr. Paul Klein, of Budapest, and Drs. S. E. Sheppard and L. W. Eberlin, of the Eastman Laboratory staff. Officials state that the principle of the processes controlled by the new organization is the electrolytic deposition of rubber on the anode which serves as the mold or form. Methods of suspending compounded ingredients in the latex have been perfected as well as means for maintaining a constant concentration of the latex mixture. The processes have been used in the factory of the Ungarische Gummiwaaren-fabriks Actiengesellschaft, Budapest, under the direction of Dr. Paul Klein and thorough tests have been made in America in the laboratories of both the Eastman Kodak Company and the Goodrich Company.

Extensive laboratory research has discovered valuable pharmaceutical properties in certain animals and the experimentation of the packing-house chemist is expected to develop other important humanitarian assets. In the early history of the packing house the inedible portions of the animal were regarded as pure waste. Today, however, waste is practically unknown and what was once thrown away is sold. Insulin, obtained from the pancreas of cattle, hogs, and calves, is the latest, most important discovery in the glandular field. The suprarenal gland yields epinephrin which is used to prevent hemorrhage during and after operations. A substance from the pineal gland has been developed to make mentally defective persons more nearly normal. The pituitary gland contains a substance which has a tremendous stimulating action on the involuntary muscles and is of inestimable value in obstetrical cases. Other substances of pronounced medical value are: thyroid extract for curing weak-minded children and other thyroid preparations to treat imperfect bone hardening, including rickets; kephalin and lecithin which stop bleeding quickly and counteract the poisons of snakes and insect bites; pepsin used in treating indigestion; and red-bone marrow and spleen which are used for anemia.

According to a report of the Minerals Division of the Department of Commerce, asbestos takes its place among the widely used products in American industry for the supply of which we are dependent on foreign sources. Only about one-third of one per cent of the world's asbestos is produced in the United States while the annual consumption in this country is more than four-fifths of the world's production. During the five-year period of 1920–1924, the average world consumption of asbestos amounted to 187,245 short tons. During the same period the average annual consumption in this country was 161,225 tons. Last year the entire world produced 330,892 tons; the United States produced a little more than 1000 tons and imported 205,821 tons. The value of United States imports of asbestos in 1925 was more than $7,000,000. Exports of manufactured asbestos, with the exception of roofing, during the period totaled $2,407,000. The increasing importance of asbestos to modern engineering and mechanical practice, as well as to the efficient construction of building wherever heat insulation and fire protection are involved, the report points out, mark asbestos as an important index of progressive efficiency in the conservation of energy and elimination of waste in national economy.

The *Iron Age* reports the construction of a new plant by the National Tube Company, at Lorain, Ohio, in which iron will be produced direct from the ore without the use of a blast furnace. The process to be used is one that has been tried out extensively in England and which has been further developed by experimentation in this country. According to the *Iron Age*, the process calls for the crushing of the ores, after which they are charged with coal into a rotary kiln heated to a definite temperature. The fine material then passes into a second kiln heated to a higher temperature, thence to a third kiln, where it is subjected to sudden chilling. The next step is to pass the material over magnetic separating rolls. Because there is no calcining of the ore as it passes through the rotary kilns, the material emerges in a granular form and of practically the same size as when it entered the first kiln. Some of the details of handling the material for charging in open hearth or electric furnaces are yet to be worked out. The process is known as the Hornsey process.

The gift of one-twenty-eighth of an ounce of radium, worth $100,000, made by the women of America to Madame Curie in 1921, has been instrumental in establishing and proving a new law of nature, according to *Science Service*. Mme. J. S. Lattes, a worker in Mme. Curie's laboratory, has described in *Annales de Physique* her studies of the filtering of radium

rays. She was able to confirm definitely, using the American radium, a law discovered last year by Georges Fournier, according to which there is a simple mathematical relation between the absorption coefficient of a material and its atomic number. She also attained her original object, which was to learn how to avoid the destruction of the flesh or necrosis which occurs when a radium tube is improperly used. Essentially her method is to use first a thin sheath of a dense metal, such as platinum, around the radium and then to wrap the tube in many layers of light material such as gauze to absorb the secondary rays issuing from the platinum.

The isolation and crystallization of the first enzyme has been achieved by Dr. James B. Sumner, assistant professor of biological chemistry at the Cornell Medical College, according to *Science Service*. Drs. Viola A. Graham and Charles V. Noback were associated with Dr. Sumner in this work. The enzyme isolated is known as urease and occurs in the jack bean, soy bean, and a great many kinds of bacteria. It has been found in the horseshoe crab and in the lining of the stomach. Urease has been prepared by Dr. Sumner as octahedral crystals that are slightly larger in diameter than human red blood corpuscles. The crystals are protein and belong to the class known as globulins. They are able to transform their own weight of urea into ammonium carbonate every 1.4 seconds at room temperature. The isolation of urease has opened up new fields for research and is expected to aid in the solution of many problems of the chemistry of enzymes and to lead to the isolation of still other enzymes.

A plea for scientific research as an independent profession was made by Dr. Charles R. Bardeen, dean of the medical school of the University of Wisconsin, at the alumni banquet at the Johns Hopkins Fiftieth Anniversary Celebration. The progress of medical knowledge demands more men who are purely research workers and who do not have to carry out the development of their ideas as a side line to teaching or clinical practice or some other job. In the medical school of the future neither equipment nor curriculum should be hard and fast but plastic, Dr. Bardeen stated. Buildings should be erected and equipped to meet specific needs of individual investigators who have been proved by past effort to be worthy of such aid. Dr. Bardeen further said: "Research in fields of knowledge not immediately applicable to human needs is not likely to satisfy the immediate personal needs or desires of any except scientific workers in neighboring fields. It is not certain to help us as individuals to meet further contingencies.

It does, however, offer the present generation the opportunity to make the coming generation the finest of gifts, increased mastery of fate. Funds for research will be forthcoming in adequate amounts when the public learns to take pride in the achievements of research."

German Has New Gold Remedy for Tuberculosis. Preliminary announcements of a new gold treatment for tuberculosis have reached England from Berlin.

Prof. Erich Leschke, of the medical faculty of the University of Berlin, has been working with a new gold compound called triphal, according to the German correspondent of the medical journal, *Lancet*. Injections of one-quarter of a grain of the new compound are administered every four days to patients in various stages of the disease, and it has also been used before performing the operation known as pneumothorax, when there is a cavity in one lung and lesions in the other. Pneumothorax is a process whereby one lung is collapsed to give the tubercular lesions a chance to heal.

The results so far are encouraging, according to Prof. Leschke, but he is unwilling to give out more information or make further statements until the remedy has been more completely tested.—*Science Service*

Synthetic Compounds Destroy Leprosy Germs. Synthetic acids similar to those made from chaulmoogra oil for the cure of leprosy have been found to be just as effective against the disease as the naturally occurring substances which have heretofore been used. Dr. Roger Adams, of the University of Illinois, who first made the artificial substances, has recently tested them out against the leprosy bacillus, he told the American Chemical Society meeting at Philadelphia.

Dr. Adams, has not only synthesized chaulmoogric and hydnocarpic acids, both of which are deadly to the leprosy germ, but also a series of thirteen chemically related substances which also have bactericidal qualities. The advantages of making the substances artificially is that they can be prepared in a purer form and may be, therefore, superior in application to the products derived from nature.—*Science Service*

Copper Speeds Meat Roasting. Roasts run through with skewers made of copper are not only juicier, more tender, and more appetizing than those baked in the ordinary way but they also require 30 per cent less time for cooking.

Such are the findings of experts of the home economics department of the University of California. This culinary discovery is explained on the grounds that the copper serves to carry heat into the interior of the roast evenly and rapidly while meat fiber alone has a very low heat conductivity.

The experimenters maintain in their report to the *Journal of Home Economics* that the more copper they used the less the meat lost weight during baking, thus giving an obvious economy of meat shrinkage as well as time and fuel.—*Science Service*

Drives Metal through Glass into Vacuum. The metal potassium can be deposited through the walls of a sealed glass bulb and forms a coating on the inside, according to V. Zworykin, of the Westinghouse Company's research laboratories. Such a bulb may be used as a photoelectric cell, which gives a minute electric current when light falls on it, and is used to transmit photographs by telephone wires and radio.

Although it has been known for some time that another of the alkaline metals, sodium, can be deposited into an evacuated tube, or even into an ordinary electric light, substitution of potassium for sodium in the electrolyte or solution used for the purpose gave negative results.

In the recent tests, however, glass containing potassium instead of sodium was used, and the potassium was deposited successfully.—*Science Service*

ABSTRACTS

Analysis of Iowa Placement Tests. F. A. LANGLIE. *J. Appl. Psych.* **10,** 303–14 (1926).—The paper presents a detailed statistical analysis of the results secured from giving the Iowa Placement Tests and the Minnesota Intelligence Tests to 241 entering freshman engineering students in Minnesota University in 1924. Iowa Placement Tests consisted of an "aptitude" and "training" test in English, mathematics, and chemistry. Each of these test results was correlated with the others and with the intelligence scores. A high degree of correlation between aptitude and training was found in each subject. The data indicated that in chemistry and mathematics a training test plus an intelligence test measured practically all that is measured by an aptitude test and a training test in these subjects. Aptitude seems to be a combination of the factors of general intelligence plus training. S. R. P.

The Identification of Olive Oils Obtained by Solvent Extraction. STEFANO FACHINI. *Giorn. chim. ind. applicata,* **8,** 178 (1926).—Chemical differentiation is demanded of laboratories between normal olive oils obtained by pressure and those of inferior quality obtained from the residual cake by solvent extraction. A test has been devised to detect these oils even if present in normal olive oils in small quantities. Two or three cc. of oil are treated with an equal volume of acetic anhydride and warmed with stirring. The mixture is then cooled and filtered through a filter moistened with the anhydride. A drop of concentrated sulfuric acid added to the filtrate produces a cherry red color which, as water is added, becomes intensely green and finally disappears on standing. Pure normal olive oils do not give the above test. O. GELORMINI

The Chemical Reactions of Hydrogen Atoms. HUGH S. TAYLOR. *J. Am. Chem. Soc.,* **48,** 2640–8 (1926).—The existence of free atoms of hydrogen was clearly shown by the work of Langmuir (*J. Am. Chem. Soc.,* **34,** 860; **36,** 1708; **37,** 417). He was able at this time to point out certain remarkable and characteristic properties which they possess. By reason of these several properties, Wood has been able to demonstrate the presence of hydrogen atoms in the high-tension discharge and Cario and Frank produced them by means of inelastic collisions of excited mercury atoms with hydrogen molecules. This paper discusses the chemical properties of the hydrogen atom produced by both of the above processes. It describes two mercury arc systems suitable for the production of hydrogen atoms. The presence of hydrogen atoms at the cathode during electrolysis, and also in oxy-hydrogen flames is indicated. The mechanism of the Cario and Frank method is discussed. A. P. B.

The Use of Potassium Bi-iodate as a Standard Substance in Alkalimetric and Iodimetric Titrations. I. M. KOLTHOFF AND L. H. VAN BECK. *J. Am. Chem. Soc.,* **48,** 2799–801 (1926).—Potassium bi-iodate is shown by the authors to be a very satisfactory standard for both alkali and thiosulfate since the equivalent weight is high and iodic acid behaves as a very strong acid toward indicators. The method of Shaffer and Hartman is used for its preparation. Potassium chlorate solution, powdered iodine, and conc. HCl are heated together. The yield is about 70 per cent. The second or third recrystallization gives a very pure product, approximating 99.98 per cent. Tables of laboratory data are included. A. P. B.

A Method for Differential Potentiometric Titration. D. A. MACINNES AND PAUL T. JONES. *J. Am. Chem. Soc.,* **48,** 2831–6 (1926).—It has been repeatedly shown that the data obtained from potentiometric titrations can be much more readily interpreted if, instead of plotting the electromotive force E against the volume of reagent V, the tangent to that curve $\Delta E/\Delta V$ be plotted against V. This latter curve shows an unmistakable and sharp maximum instead of a point of inflection. Cox (*J. Am. Chem. Soc.,* **47,** 2138) described a laboratory set-up employing two burettes and two beakers whereby data closely related to the above quantity, $\Delta E/\Delta V$ may be obtained. The authors have adapted this method to a single burette and beaker by the simple device of using a protected electrode which temporarily prevents a small amount of solution around the electrode from mixing with the rest of the solution, thus forming a concentration cell. The electrode is described in detail and several typical curves are shown. The method is capable of high accuracy and is applicable wherever potentiometric technic is possible. A. P. B.

A Study of the Relation between Ability and Achievement. JOHN R. MCCROY. *Educ. Admin. and Superv.,* **12,** 481–90 (1926).—A resumé of a study of 357 entering first-year students in the St. Cloud, Minn., State Teachers' College in 1925. The purpose of the study was to determine, if possible, which students applying for admission to college are apt to make an unsatisfactory academic record. Intelligence scores and high-school marks were used as a criterion. A fairly close correlation was found

between high-school marks and college marks as also was true between intelligencs test scores and college marks. The predictive value of a student's probable succese was increased when both intelligence test scores and high-school marks were considered.
S. R. P.

A Hand-Book of Major Educational Issues. *Res. Bull.* (*N. E. A.*), **4,** 163–234 (1926).—Present major educational issues are enumerated and discussed. Important charts, tables, and bibliographies accompany the discussion of most articles. The issues presented are: The place and importance of the public school in our Republic; the essentials of a modern school system; a trained and understanding administrative and supervisory staff; a living and developing curriculum adapted to social and individual needs; an adequate school plant; a school term of reasonable length and high regularity of attendance; a just and effective method of providing school support; an effective form of organization; an interested, intelligent, and supporting public; and growth of teachers in the service. S. R. POWERS

The Influence of Sex on Scholarship Ratings. D. G. PATTERSON AND F. A. LANGLIE. *Educ. Admin. and Superv.*, **12,** 458–68 (1926).—Surveys among high-school seniors made in Indiana and Massachusetts indicate that sex differences in tested intelligence have constantly favored the boys while sex differences as revealed by scholastic marks have favored the girls. Some educators have attempted to explain the difference by saying that (1) school work may be better adapted to the abilities of the girls or reach and appeal more to the girls and (2) the girls may have certain mental characteristics necessary for school success. Surveys at the University of Minnesota have shown similar results on the college level. However the use of new type objective tests in the last two years has tended to make the sex differences almost entirely disappear. The authors conclude that sex differences are pseudo-differences and that the scholastic ability of girls has been over-rated and the seeming superiority has been due to rewarding personality traits rather than genuine achievement. S. R. P.

The Fiftieth Anniversary Meeting of the American Chemical Society and the Progress of Chemistry in America. E. E. SLOSSON. *Sci. Mo.*, **23,** 373–84 (Oct., 1926).—This report of the American Chemical Society is filled with interest and gives the reader a good idea of what is being accomplished in the field of chemistry. So much was said of catalysts and their effect as accelerators that one might look upon chemistry as "the science of short cuts." It is suggested that catalytic action, which has been so little understood, may find an explanation in the discovery of Dr. Irving Langmuir that atomic hydrogen, prepared by passing a stream of the gas through an electric arc, burns in the hydrogen with a much higher temperature than it is possible to obtain with the oxyhydrogen blowpipe. The apparatus is similar to the ordinary blowpipe except that a stream of hydrogen from a small copper tube is driven between the tips of two tungsten electrodes. A double flame is produced. The inner flame consists of atomized hydrogen, burning in molecular hydrogen, while around this molecular hydrogen is burning in air. The heat easily melts a tungsten wire held in the tip of the inner flame. The activity of atomic hydrogen in the cold was shown by Dr. H. S. Taylor. He prepared atomic hydrogen by use of the mercury vapor lamp. The mercury atoms are "excited" by means of an electric current. This causes the expulsion of electrons to the outer orbits of the atoms. When one of these excited mercury atoms collides with a hydrogen molecule disruption is apt to take place giving atomic hydrogen which siezes on the atoms of any other element at hand.

While there was much discussion of rubber and the possibility of its synthesis it was agreed that there is little danger as yet of driving the rubber plantations out of business. The production of petroleum from natural gas, the synthesis of cellulose and the preparation of foodstuffs from petroleum were shown as possible achievements of the future. Work already accomplished along these lines not only shows them to be not impossible but points out some of the remarkable achievements in the field of chemistry. G. W. S.

Research in the College. S. R. WILLIAMS. *Sch. and Soc.*, **24,** 437–43 (Oct. 9, 1926).—"College students must be exposed more thoroughly to the ideals and aims of the spirit of research" which, the author states, is the desire to seek for new truth. The research method is a self-educative process and must, therefore, develop the powers of thinking. The institutions offering three five-hour courses are doing much more toward developing constructive thinking than those which allow a student to take eight two-hour courses.

A teacher should keep alive in his subject by doing some phase of creative work and furthermore research work should be introduced to undergraduates throughout their entire college course. A teacher should not only dispense knowledge but create

it and his schedule should be such as to permit his undertaking research work, not to such an extent that it is a detriment to his teaching, but there should be a sane balance between each as one contributes to the other. How may the research spirit be developed in the undergraduate? First, definite research courses should be offered which the student might elect, and second, for those students above the average there should be opportunity to participate in creative work in the subject in which they are interested. The gifted student should be given a problem which will keep him interested rather than let him drift along with the slower ones. It is important that during their college days, students should be trained so that they may meet their life problems with intelligence and success. As Wiggam said, "The function of the college is to draw out and utilize each man's individual capacities, emotions, and powers." K. S. H.

Some New Analytical Reactions of the Platinum Metals. S. C. OGBURN, JR. *J. Am. Chem. Soc.*, **48**, 2493–507 (1926).—The six elements, ruthenium, rhodium, palladium, osmium, iridium, and platinum present many difficulties to any method for their separation and detection. Many attempts have been made, using a wide variety of inorganic and organic reagents. The author presents, in tabular form, reactions of chloride solutions of each of the six elements with 33 typical inorganic and about 90 organic compounds, selected from the various classes and including those known to react with these metals. The most reactive inorganic compounds, acting to form precipitates, are the sulfides, thiosulfates, hydroxides (caustic), halides, certain reducing agents as hydrazine, hydroxylamine and phosphorus, and certain metals, such as zinc or magnesium, more highly electro-positive than platinum. The most reactive organic compounds are the alkaloids, oximes, aromatic amines, non-substituted nitrosohydroxy compounds, nitroso aromatic amines, pure hydroxy compounds, and aminohydroxy compounds. Several new color reactions are described and theoretical considerations relative to the formation of coördinated salts are discussed. A. P. B.

A Qualitative Separation of the Platinum Metals. S. C. OGBURN, JR. *J. Am. Chem. Soc.*, **48**, 2507–12 (1926).—A new gravimetric scheme of analysis of the platinum metals is given. It is short and comparatively easy for those unfamiliar with the detailed chemistry of the metals to carry out. It is well adapted for qualitative or semi-quantitative determinations, having an accuracy within 2.5 per cent for each of the six metals. A table of results of the analysis of a mixed solution of the chlorides of the six metals is given to illustrate. A. P. B.

The Determination of Selenium and Tellurium by Means of Potassium Permanganate. W. T. SCHRENK AND B. L. BROWNING. *J. Am. Chem. Soc.*, **48**, 2550–3 (1926).—Selenous and tellurous acids may be quantitatively determined by use of potassium permanganate in acid solution. The method is not without possible errors and precautions, and these the authors have carefully determined. Chlorides must be absent. Addition of disodium phosphate prevents precipitation of manganese dioxide. The excess permanganate may conveniently be titrated electrometrically by use of ferrous sulfate solution. Selenous and tellurous acids in the same sample may be determined by using a combination of the dichromate and permanganate methods. The method is outlined and tables of results are shown. A. P. B.

Efficient Teaching and Retirement Legislation. ANON. *Res. Bull.* (*N.E.A.*), **4**, No. 3, 161 (1926).—The *Research Bulletin* gives a critical review of the fundamental principles of a retirement system and some data relating to the acceptibility of these fundamentals. Reasons are given why every state should have a sound teachers' retirement law and why the teachers should be interested in such a law. The *Bulletin* lists the states having such laws and gives a tabulation of the main provisions of eleven retirement laws. A very valuable annotated bibliography is also given. S. R. P.

The Measurement of Persistence. JOHN MORGAN AND HAZEL LUCILLE HULL. *J. Appl. Psych.*, **10**, 180–7 (1926).—Persistence is a mental attitude which arises as a result of a definite environmental situation. It is that attitude which drives a person, once he has undertaken a task, to complete it to his own satisfaction. It is a trait which may enable a person of deficient intellectual ability to succeed, whereas one who has ability and lacks persistence may fail. There has been an over-emphasis on the quality and quantity of work produced per unit of time. A persistence test consisting of a maze was worked out by the authors and given to 100 pupils. It was reported that one can rate a stranger on this scale as accurately as this same person can be rated by intimate personal acquaintance on a basis of repeated observations. S. R. P.

Perceptibility of Automobile Numbers. JAMES D. WEINLAND. *J. Appl. Psych.*, **10**, 277–83 (1926).—The number of automobiles has been increasing so rapidly that several states have passed the million mark. As a result license plates have become

quite cumbersome and difficult to read. A study has been made in the psychology department of Columbia University on the "effect of grouping upon the perception of digits." The results of the experiment showed that a combination of letters and digits tended toward greater accuracy in perception. A 25 per cent increase in efficiency in perceptibility was found in over 6-digit license numbers. S. R. P.

Value of Examinations. EDITORIAL. *Educ. Outlook* (London), **78,** 291 (1926).—This editorial questions the value of the external tests prepared by outside examiners and given to the pupils of the English secondary schools. Do the results of the tests, upon which so much depends, really give an assessment of the intellectual aptitude of every candidate taking them? Real education may often be sacrificed in order that the pupils pass the external tests. External tests are valuable if rightly used and rightly carried out, but they become an impediment to education if they are used as the sole instrument for judging the work of children and teachers. A plea is made for new type tests, similar to so-called "tests of intelligence" which are in part, at least, tests of knowledge. S. R. P.

Some Advanced Ideas in Engineering Education. W. TRINKS. *J. Eng. Educ.*, **16,** 602–8 (May, 1926).—It is proposed that a book fund be started for paying the most competent engineers salaries for writing books on advanced engineering subjects comparable to European books and that the teaching of post-graduate specialties be selectively distributed among the colleges. C. R. KINNEY

Engineering Course as a General Education. E. WILLIS WHITED. *J. Eng. Educ.*, **16,** 614–20 (May, 1926).—Since the calculus is of no intrinsic value to ninety per cent of the engineering students taking it, etc., it is suggested that substitution for all or part of the calculus given to engineering students by a thorough course in commercial law be considered. C. R. KINNEY

Reasonable Demands upon Students' Time. E. S. SMITH. *J. Eng. Educ.*, **16,** 621–7 (May, 1926).—A study of the time necessary for an average student to prepare for recitations by the "Junior Faculty" of the University of Cincinnati, showed that the sophomore and junior students were overloaded, largely due to the writing of outside laboratory reports. The general faculty then adopted a definition of credit hours which should make it possible for a student to prepare for his recitations in three hours per night or eighteen hours per week. C. R. KINNEY

Bromine from Salt Water. A. MORESCHI. *Giorn. chim. ind. applicata,* **8,** 115 (1926).—Brine is concentrated and then treated with chlorine. The liberated bromine is extracted with CCl_4. The addition of $Ca(OH)_2$ to this solution yields a product called bromide of lime. Practically a quantitative yield of bromine may be obtained by the addition of an acid. O. GELORMINI

The Teacher and Educational Advertising. WINIFRED STUART GIBBS. *Am. Food J.*, **21,** 375 (1926).—Teachers who make use of educational material put out by commercial organizations are advised to scan all material critically for proofs of scientific accuracy; to put themselves in the place of the one who wrote it and pass on any suggestions that class-room use of the material may have developed; to remember that the educational worker in food manufacturing organizations has a different problem from the teacher; that the teacher may also learn much from industry.
J. W. HOWARD

Growth and Uses of Lacquer Plasticizers. M. R. TRIMMER. *Chemicals,* **26,** 7–11 (Aug. 30, 1926).—A review. C. R. KINNEY

Some Special Finishes on Textiles. ANON. *Chemicals,* **26,** 22–4 (Aug. 16, 1926).—Discussions of recently patented processes for producing various finishes on textiles. C. R. KINNEY

Argon and Helium. T. H. NORTON. *Chemicals,* **26,** 25 (Aug. 9, 1926).—Interesting essays on these rare gases, with especial emphasis on their commercial uses. C. R. KINNEY

Rosin: Its Production, Character, and Uses. ANON. *Chemicals,* **26,** 9 (Aug. 2, 1926).—A symposium on "Rosin." C. R. KINNEY

A New Ceramic with Possibilities—"Isolanite." A. C. LESCARBOURA. *Chemicals,* **26,** 14–5 (July 5, 1926).—During the World War the French developed a new ceramic called isolanite which "brings to the ceramic industry what the Bessemer process brought to the old iron industry." Isolanite is of the same general family as porcelain, but it is of extreme toughness and hardness. It is so tough that a dish can be dropped twenty feet to a stone floor without chipping anything but the floor, and so hard that only diamond surpasses it. On the scale of hardness it is 9.5. Although it cannot be machined after hardening, the moulded material can be machined previously and the finished product has quite the same precision as metal products. Isolanite withstands

wear well. It withstands intense heat and temperature changes such as from red heat into water without cracking. The conductivity of heat and electricity is very low. These latter properties have won for isolanite ready and wide applications in radio reception and transmission. Chemically, the material is inert to the action of commercial acid, alkalis, salt, and solvents. It is non-porous and does not absorb liquids in constant contact with it. C. R. KINNEY

The League of Nations Committee and Institute of International Intellectual Cooperation. VERNON KELLOGG. *Science*, **64**, 291–2 (Sept. 24, 1926).—The fourteen members of the International Committee and Institute of Intellectual Coöperation represent fourteen countries. The President is Professor Lorentz of Leiden.

"The special function of the committee and institute is the promotion of international undertakings in the various fields of scholarship. . . . . They hope to be able to find means of giving some special support to scholarly undertakings in countries facing particular difficulties in this regard."

The League of Nations Committee now has the International Institute of Intellectual Coöperation organized in January of this year to carry forward as a permanent organization the recommendations outlined by the Committee. The International Institute "has a director and vice-director, ten chiefs and assistant chiefs, all serving full time, and, in addition, a number of occasional special investigators serving for limited periods. The institute is located in Paris. G. H. W.

The X-Ray as a Puzzle Solver. HERBERT WARING. *Am. Mag.*, **102**, 38–9, 92–100 (Oct., 1926).—The article represents a journalist's impression as he is introduced to various practical uses of the X-ray. Its use in diagnosis by the medical profession is not mentioned. The chain of services passed before the reader included the finding of pipes and wires in walls; detection of the genuineness of "old master" paintings; as an aid in fitting shoes; as a check upon methods of inspecting steel rails for railroads; as a means of locating foreign objects upon the "insides" of electrical machinery; for inspecting spark plugs, tooth brushes, primers in cartridges, safety fuses, golf balls; detecting grit or sand in candy, freshness of eggs, pearls in oysters; distinguishing real from fake diamonds, natural from artificial pearls, and even to the recovery of a diamond from the stomach of a native in a Kimberley, South Africa, diamond mine. Some space is given to the work of Doctor F. C. Langenberg and Doctor H. H. Lester at the United States arsenal at Watertown, Mass. Their work is said to be largely concerned with the inspection and control of metallurgical processes. B. C. H.

Copper in Distilled Liquors. ANON. *Tech. Rev.*, **88**, 196 (1926).—Herman C. Lythgoe, Head of the Division of Food and Drugs of the Massachusetts Department of Health, has discovered that much of the distilled liquor sold in Massachusetts contains copper.

"Since the coming of prohibition, liquor analysis has increased steadily, averaging now about 9000 samples a year. Of 1544 samples examined for copper 163 were positive." S. W. H.

Research in America. ANON. *Tech. Rev.*, **28**, 256 (1926).—"No American need go to Germany to study chemistry; he will be better taught at home," so declared Dr. A. D. Little in an address on the "Application of Research to Industry" at Swarthmore Chapter of Sigma Xi. "America has outstripped Germany in the amount manufacturers are spending on research."

To illustrate what research had accomplished, he cited that it cost twenty times as much to produce a given amount of light in 1880 as it does today. S. W. H.

A Method of Teaching Chemistry. MARY ISABEL HENKEL. *Sch. Rev.*, **34**, 591–8 (1926).—An outline of the author's method in which the project method is introduced eight or nine weeks before the close of the second semester.

Method presents four main factors: 1, Time; 2, books; 3, equipment; and 4, personal equation. Favorable reports on students so trained and by students indicates that this method gives better preparation than the standard method and emphasizes teaching the pupil rather than the subject. B. H. B.

The New Elements. L. F. YNTEMA. *Sch. Sci. and Math.*, **26**, 707–9 (1926).—A brief, interesting account of methods used in search for new elements, with some results. B. H. B.

Local Activities and Opportunities

N. S. T. A. The district sections of the Nebraska State Teachers' Association met in six places throughout the state November 3rd, 4th, 5th, and 6th. Doctor E. E. Slosson appeared upon the general programs of all districts. Practically every district offered a program given over to science in the high schools. These programs, almost without exception, devoted themselves to the general problems of science teaching rather than any particular high-school science subject.

Assistant Professor Ralph Tyler, science supervisor in the University of Nebraska's Teachers' College high school, is at the University of Chicago on leave of absence for the current year working toward his Ph.D. degree. Mr. Philip Johnson, who did graduate work in chemistry in the University of Minnesota last year, is serving as Professor Tyler's successor during his absence.

University of Arkansas. The chemistry department of the University of Arkansas is looking forward to better quarters. With the completion of the new Agriculture building and the new Engineering building they will be given some additional space for their work.

Dr. Harrison Hale, head of the chemistry department, has been giving a series of radio talks on chemistry from the university broadcasting station, KUOA, which have aroused a great deal of interest.

Dr. Hale reported on the semicentennial meeting of the American Chemical Society, at the meeting of the Arkansas Education Association on November 11th.

Jacob R. Meadow, graduate scholar in chemistry at the university, will represent the university as candidate for the Rhodes scholarship.

University of Mississippi. In the department of chemistry, Drs. G. H. Woollett and V. A. Coulter have been advanced to the rank of Professors. Dr. H. F. Johnstone who received the degree of Ph.D. from the University of Iowa in August has been added to the staff with the rank of Assistant Professor.

American Association for Medical Progress, Inc. Mr. George Murnane, President of the American Association for Medical Progress, announces the election of Honorable Charles Evans Hughes as Honorary President of the Association, succeeding the late Dr. Charles W. Eliot who was long identified with the work of the Association.

The American Association for Medical Progress is an organization of laymen with staff headquarters in New York City. Its purpose is "to encourage experimental research for the advancement of medical science, and to inform the public concerning the methods and discoveries responsible for man's increasing control over animal and human diseases." Mr. Hughes has been for a considerable period connected with the Association as Honorary Vice President.

New York State Science Teachers' Association

Headquarters, The Hotel Syracuse

December 27 and 28, 1926

Monday, Dec. 27th at HOTEL SYRACUSE. For room number, inquire at the Information Desk of the Hotel.

2.00 P.M. Annual Meeting of the Council.

3.00 P.M. "Practical Suggestions for the Teaching of Physical Geography to High-School Students." Dr. Otto D. von Engeln, Cornell University, Ithaca, N. Y.

4.00 P.M. Round Table Discussion. Leader, Dr. Chas. N. Cobb, State Department of Education.

4.30 P.M. "Some Intimate Observations of a Few of Our Birds." Mr. Guy Bailey, Geneseo State Normal School.

6.00 P.M. Banquet with the Academic Principals at the Onondaga Hotel.

Tuesday, Dec. 28th at CENTRAL HIGH SCHOOL.

9.00 A.M. Registration. Outside Room 307.

9.30 A.M. Room 307. "Educational Tests and Measurements." Dr. Howard Pillsbury, Deputy Superintendent of Schools, Buffalo.

10.30 A.M. Room 307. "Suitable Tests and Measurements for Science Students." Report of Committee composed of Dr. C. F. Hale of Albany, Mr. Harry Carpenter of Rochester, and Mr. Glen Van Eseltine of Syracuse.

12.30 P.M. Business Men's Lunch at the Hotel Syracuse, $1.00.

2.00 P.M. Room 307. "The Laboratory Experiment in Physics." Mr. Robert W. Fuller, Stuyvesant High School, New York City.

3.00 P.M. Room 307. "Preparation and Properties of Metallic Barium." Mr. A. J. King, Syracuse University.

4.00 P.M. Room 307. Report of Nominating Committee and Annual Election of Officers.

4.30 P.M. Section Meetings, Round Table Discussion. (Please send in, or bring in topics which you wish discussed, so that the section leaders may form a program.)

Physics, Room 305. Leader, Robert W. Fuller.

Biology, Room 319. Leaders, Miss Ida Reveley of Wells College, Aurora, and Mr. Bailey of Geneseo Normal School.

General Science, Room 308. Leader, Harry Carpenter.

Chemistry, Room 312. Leader, Mr. George Fowler.

8.00 P.M. HOTEL SYRACUSE—Business Meeting of Association.

* ROOMS. The Hotel Syracuse has made a special rate to those attending the meetings of the State Science Teachers' Association; to obtain this rate, please reserve rooms in advance if possible and mention the fact that you are to attend these meetings.

University of California, Southern Branch. Mr. H. Darwin Kirchman, for four years instructor of chemistry at the University of Hawaii, has been appointed half-time instructor in chemistry at the University of California, Southern Branch. Mr. Kirchman is continuing his graduate study at the California Institute of Technology.

N. E. A. C. T. The 102nd meeting of the New England Association of Chemistry Teachers was held at Waterbury, Conn., on December 4th. The program included a motion picture entitled, "From Mine to Consumer;" a special industrial display and new apparatus; address of welcome by Principal Joseph P. Kennedy of Wilby High School, Waterbury; "What Industry Expects of the Chemist," by Luther W. Bahney; "Environmental Chemistry in the Class-room," by Charles H. Stone; and "Preparation and Use of Pharmaceutical Chemicals," by A. J. Hill.

Association of Science Teachers. The following program was given on November 27th at the University of Buffalo at the sixth annual meeting of the Association of Science Teachers of the Middle States and Maryland in conjunction with the association of Colleges and Secondary Schools:

1. "The Important Objectives of Secondary School Sciences," by A. P. Sy.
2. Reports from the Committee on Biology, Edward E. Wildman, *Chairman;* Committee on Physics, Earl R. Glenn, *Chairman;* and Committee on Chemistry, Jesse E. Whitset, *Chairman.*
3. Discussion.
4. "The Evolution of Industry as Related to the Evolution of Scientific Knowledge," by R. E. Rose.
5. Business meeting.

At the close of the meeting the following resolution was adopted by the Association: Resolution on Freedom of Teaching. WHEREAS there have been legislative

enactments in some states seeking to restrict the teaching of certain subjects; and whereas the extent of human knowledge is such that it is often impossible to reach a wise conclusion as to the merits of different studies, or as to what is true or false in any particular field, unless one has devoted many years to its study; *be it resolved* by the Association of Science Teachers of the Middle States and Maryland at this its meeting, November 27, 1926, in Buffalo, N. Y.; that the first object of school teaching in any given science must be to present fundamental scientific truth in the clearest, simplest, and most convincing manner, and as generally accepted by experts in that science.

The following officers were elected for the ensuing year: President, Dr. Charles E. Dull, Newark, N. J.; Vice President, Dr. M. Louise Nichols, Philadelphia, Pa.; Secretary-Treasurer, Miss Elizabeth W. Towle, Bryn Mawr, Pa.; Members of the Council, Henry R. Hubbard, Plainfield, N. J., Winifred J. Robinson, Newark, N. J., and J. E. Whitsit, New York City.

Motion was made and carried that the retiring President become *ex officio* member of the Council.

University of Arizona. "The Constitution of the Atom" was the subject of a series of lectures delivered November 1st–5th, at the University of Arizona by Professor J. H. Hildebrand, University of California. The lectures were given under the auspices of the department of chemistry and aroused so much interest that it became necessary after the first day to move from the chemistry lecture room to the University auditorium in order to accommodate the audiences. The lectures were illustrated abundantly with slides and experiments and were stimulating to the layman, the members of the chemistry department and to many undergraduates. On the evening of November 4th an informal dinner was given in honor of Professor Hildebrand at the Old Pueblo Club by the Sigma Xi Club, at which time the speaker told of the University of California, its administration, research activities, etc., and various phases of university teaching. The Arizona Section of the A. C. S. held a banquet on the following evening, November 5th, at the University Commons, with thirty-two members present. Professor Hildebrand again gave an inspiring address on the "Spirit of Science," after which the meeting was devoted to an informal discussion of various special aspects of atomic and molecular structure. The University of Arizona, located as it is in the remote Southwest and isolated from centers of chemical activity, welcomed this visit and lecture series by Professor Hildebrand, and his stimulating points of view will long linger in our memories.

Teachers' College, New York City. At the last meeting of the Board of Trustees of Teachers' College a gift of $100,000 made by Mrs. Richard M. Hoe, was announced. This gift is for the purpose of endowing a professorship in education, to be known as the "Richard March Hoe Professorship," as a memorial to her husband. Mr. Hoe was a member of the Board of Trustees from 1914 until his death in 1925.

At the same meeting Mr. Valentine E. Macy, a son of Mr. V. Everett Macy, Chairman of the Board of Trustees, was elected a Trustee of Teachers' College.

The Trustees granted the request of Professor George A. Coe to be retired from active service on February 1, 1927. Professor Coe is known throughout the country as the author of "What Ails Our Youth?"

University of Florida. The thirteenth meeting of the Florida Section, A. C. S., was held on Saturday afternoon and evening, November 20th, at Tallahassee. The members of Science Society of the Florida State College for Women acted as hostesses to the visiting chemists. The business session began at 3.30 in the afternoon and was followed by a dinner in the university dining rooms.

The evening session convened at 8.00 P.M., when Dr. B. B. Ross, of Alabama

Polytechnic Institute and State Chemist of Alabama spoke on "The South as an Inviting Field for the Chemical Industries."

D. C. Chemistry Teachers. The fifth meeting of the District of Columbia Chemistry Teachers' Association was held Friday evening, November 19, 1926, at the George Washington University. The following officers of the Association were elected for the year 1927:

President, Doctor Colin M. Mackall of George Washington University.

Vice President, Mr. Guy Clinton of Central High School.

Secretary, Mr. Elmer H. Krehbill of McKinley High School.

Treasurer, Mr. George S. Edelen of Business High School.

Contributing Editor to Journal of Chemical Education, Mr. Louis W. Mattern of McKinley High School.

Executive Committee, Doctor H. P. Ward of the Catholic University of America; Doctor Joseph A. Muldoon of Georgetown University.

Following the election of officers, Doctor Lyman C. Newell spoke on "Personal Experiences in Teaching Chemistry."

After Doctor Newell's talk the meeting adjourned to the Organic Laboratory for refreshments and informal discussion, with Doctor Mackall as host.

Syracuse University. Interest in the prize essay contest was so slight that a special study was made of the problem in an effort to stimulate a large proportion of our freshmen to write essays. This year, through coöperation with the English department, essays on chemical subjects will be accepted as the term papers required in English I. As a result over 400 freshmen are now writing essays.

Following a custom recently inaugurated the Syracuse Section of the A. C. S. will act as host to teachers of chemistry and their students at its December meeting. Invitations have been sent to approximately 80 schools in the Syracuse area which offer chemistry. Last year 350 teachers and pupils attended a similar meeting. The program includes an Exposition of Chemistry, a Kem Sho, and a Teachers' Conference. The Exposition will be held at the Syracuse University chemistry building all day Friday, December 17th. About 100 exhibits have been prepared, ranging from specimens of materials and "Museum Reactions" to research projects which are under way. A group of students, assigned to each exhibit will be responsible for its demonstration and exhibit. The Kem Sho will be staged Friday evening. This entertainment has of recent years taken the form of a vaudeville, which is very well received. Saturday morning the teachers of chemistry will gather for a round table discussion of "Present Trends in Chemical Education." This discussion will be led by Dr. Neil E. Gordon, editor of THIS JOURNAL. Any who are interested may obtain the "Flow Sheet" of the Exposition and Kem Sho by addressing Dr. R. A. Baker of Syracuse University.

Brown University. On September 24th, Professor G. L. Clark, of Massachusetts Institute of Technology, gave a very interesting address on "X-Rays in Pure and Applied Chemistry."

On October 11th, Professor Ernst Cohen, University of Utrecht, Holland, addressed the Rhode Island Section of the A. C. S. on "Van't Hoff, His Life and Work." Professor Cohen gave a very interesting personal presentation of Van't Hoff.

October 22nd, Professor Charles A. Kraus, director of chemical research at Brown University, addressed the Rhode Island Section on "Hybrid Chemistry."

November 23rd, Professor A. J. Hill, Yale University, spoke on the "Chemical Story of Local Anesthetics."

The December meeting of the Rhode Island Section will be held jointly with the American Electroplaters' Society and the Textile Chemists and Colorists. At this meeting, Professor Colin G. Fink will address the Section on "Recent Advances in Electroplating."

Professor Samuel T. Arnold, as a representative of Brown University, attended

the International Union of Pure and Applied Chemists held at Washington in September.

Professor Norris W. Rakestraw, Brown University, has been appointed to the Senate of Chemical Education as college representative from the State of Rhode Island.

November 12th, Mr. J. E. Robinson of the United States Rubber Company, Bristol, R. I., spoke at the students' Chemistry Club, Brown University, on the subject of the "Rubber Industry and Its Relation to Chemistry."

Dr. J. N. Brönsted, University of Copenhagen, gave the first of a series of lectures of the John Howard Appleton Lectureship on December 8th. His subject was "The Conception of Acids and Bases."

Lexington Section, A. C. S. The 115th regular meeting was held at the University of Kentucky, December 8, 1926. The program consisted of the following addresses. "A Review of the Progress Made in the Chemistry of Physiology and Nutrition," by R. K. Flege of the University of Kentucky. "Progress in Chemical Education," by Professor V. F. Payne of Transylvania College.

The Cincinnati Section, A. C. S. The 186th regular meeting of the Cincinnati Section of the American Chemical Society was held in the main auditorium of McMicken Hall, University of Cincinnati, Wednesday evening, December 8th.

The address of the evening was given by Dr. Glenn E. Matthews of the Eastman Kodak Co., Rochester, New York. His subject was "Color Photography" and the lecture consisted of a discussion of the basic principles of absorption and reflection of light, a description of color filters, and a review of the principal processes of color photography and color motion pictures. The lecture was illustrated by charts, autochrome slides, and a reel of colored moving pictures.

Makes Water-Proof Animal Glue. Ordinary animal glue can now be waterproofed and made to last as long as the best casein glues on the market. Dr. Frederick L. Browne and Clarence E. Hrubesky of the U. S. Forests Products Laboratory at Madison, Wis., disclosed their discovery at the meeting of the American Chemical Society in Philadelphia.

Although animal glue can be made water-resisting by the use of common formaldehyde the fact cannot be made use of in the woodworking industry because the reaction takes place so quickly that the glue so treated hardens before it can be applied to the surfaces to be joined, Dr. Browne said. But if a compound of formaldehyde is used instead, a sufficient amount of slowly acting formaldehyde can be introduced in that way to render the glue water-proof and still keep it fluid long enough to be used conveniently in the glue rooms of furniture factories.

The working life of the glue can also be increased by adding small amounts of certain acids, Dr. Browne said. The animal glue is then just as good for woodworking as the more expensive glues made from casein.—*Science Service*

Research Ten Times More Costly Than Publication. Between thirty and forty cents a word is about what it costs on the average to conduct the chemical research reported in two leading American chemical journals. About three cents a word is the cost of publishing the articles announcing the researches. The authors contribute their articles free to the journals and the public and posterity are the beneficiaries of the new knowledge added to the world. These figures are announced in the scientific journal, *Science*, as a result of a survey conducted by Prof. W. A. Noyes of the University of Illinois, to determine the relative cost of research and publication of results. Research necessary to produce one article amounted to $5 a word, and the scientific work behind some articles cost many thousands of dollars.—*Science Service*

Recent Books

Science and Life. Aberdeen Addresses. FREDERICK SODDY, M.A., F.R.S. Lee Professor of Inorganic and Physical Chemistry, Univ. of Oxford. First edition, 3rd reprint. E. P. Dutton and Co., New York, 1926. xii + 229 pp. 14 × 23 cm. $4.00.

Professor Soddy is well known for his researches in physical science, and as a teacher for five years at Aberdeen and now at Oxford. A mere recital of the titles of the addresses in this book should be sufficient to induce those who know Soddy's method of presentation and argument to read it from cover to cover. The reviewer did. The book takes its title from the first address, the others being on Physical Force, Man's Master or Servant; Chemistry and National Prosperity; Science and the State; The Future of Science and What Bars the Way; The Evolution of Matter; Conception of the Chemical Element as Enlarged by the Study of Radio-active Change; Matter, Energy, Consciousness, and Spirit; To the New Launch; The Ideals of a Science School.

The keynote of the first and second addresses is the statement that the history of man reflects and is dominated by the amount of available energy. Soddy deplores the fact that too often the affairs of our present-day civilization are put or left in the hands of men ignorant of science and its human consequences. Some day we shall be able to control the artificial transmutation of the elements which will mean the liberation of almost unthinkable quantities of energy, and we must be ready to appreciate what this involves, or the world as we know it now may be destroyed.

In another address Soddy says that starving, in the time-honored manner, a great pioneer of religion, or reason or art, was cheap. But starve the same type of mind in science now, and the community starves with him. Although all the benefits of modern civilization are due to the achievements of science or inventions based upon them, honor, glory, or power are not the usual rewards that come to a scientist. The scientist may be, and usually is satisfied with "the thrill that comes but once in a lifetime." But if he is to be encouraged in continuing to be of practical benefit to humanity, it is simply good business sense for the State to recognize the workers in this field.

The address on The Future of Science and What Bars the Way should be read by every member of every college curriculum committee. It will delight the scientists and enlighten the classicists. "The curricula of ancient universities accumulate rather than evolve. The new cult of science is sandwiched with a culture that came to maturity thousands of years ago. Nothing is ever abolished from a curriculum. If there were real freedom of choice the survival of the fittest would operate. But the whole system of regulations for degrees is to bolster up and perpetuate a museum of ancient learning... This perpetuates the man who is hopelessly out of tune with his environment however rational he may have been in the middle ages." Antiquated schemes of classical education, Soddy says, do not train us to keep pace with and make proper use of the physical power put into our hands by science. External nature controls humanity, and the mistake of neglecting it is serious.

Other chapters discuss recent advances in atomic and subatomic researches, and a mechanistic, or physico-chemical view of life is presented, somewhat along lines familiar to those who know Loeb's work.

In another address Soddy says that it is not good to be young in a country that is governed by worm-eaten prejudices and absurd conjuring tricks, with words which are the result of training

in ancient educational establishments. Youth will pay again as it did in the great war, unless science gets decent fair play.

Finally the author refers to the deluded victims of our curiously archaic system of classical education who point to the evils of the world which they have misgoverned, and the terrible consequences of science under their misdirection as proof of the superiority of ancient culture and ideals. Soddy suggests that as a memorial we install in our universities not only a pure faculty of Art which carries on the creative work rather than the languages of our ancestors, but also a pure faculty of Duty to foster the obligations of the twentieth century rather than the codes and creeds of mythology, ancient or feudal man.

A. P. SY

Laboratory Manual Arranged to Accompany "Principles of General Chemistry." STUART R. BRINKLEY AND ERWIN B. KELSEY. First edition, The Macmillan Co., New York, 1926. xiii + 159 pp. 9 figures. 14 × 21.5. $1.50.

As the subject of this manual indicates, the experiments are arranged to accompany Brinkley's "Principles of General Chemistry" and frequent references are made to this text. The subject-matter is divided into 47 exercises of which the last 15 are inorganic preparations. Five quantitative experiments are included among the remainder. Each exercise is divided into sections which are arranged with explanatory titles that indicate to the student what he is expected to observe. While most of the experiments are of the type usually found in laboratory manuals, the authors have grouped them in such a way that the student should not fail to see their purpose though the principle underlying them is not always so clearly pointed out. Many of them are chiefly informational, giving the student facts without showing their particular significance. This might have the effect of causing the student to look upon his chemistry as a mass of more or less unrelated facts though it should not be difficult for the instructor to make clear their relation to each other and to the principles involved. At the beginning of each exercise is given a list of the materials and apparatus for the experiments and following the exercise is a number of questions and problems.

The book is well written and directions are clear and concise. Explanations are included where the student could not be expected to know the results of his experiment. In the opinion of the reviewer the book is well suited to the purpose for which it was intended.

GEO. W. SEARS

Colloid and Capillary Chemistry. HERBERT FREUNDLICH. Translated from the third German edition by H. Stafford Hatfield. E. P. Dutton and Company, New York City, 1926. xv + 883 pp. 25 × 15.5 cm. $14.00.

Professor Freundlich, in this splendid work, has set up a standard to which few writers in the subject may hope to attain. Adverse criticism of a book, to the subject of which a writer has devoted the most of his useful life, is out of place. Even the briefest examination of Colloid and Capillary Chemistry will convince one of the soundness of this conclusion.

To begin with, the arrangement is very logical and very orderly. Too many texts and reference books on colloid chemistry are painfully haphazard affairs. Even the advanced student has difficulty in seeing the thread of continuity throughout colloid phenomena. Freundlich's book clears up this maze as the sunlight dispels the mist.

The plan of the book is well stated in the Introduction. "The first part of the book will therefore deal with the physicochemical foundations of colloid chemistry, that is to say, with capillary chemistry, the formation and interconversion of phases, and molecular motion. Upon these three foundations colloid chemistry itself will be built up in the second part of the book."

"These three foundations" have been

well and strongly built. Three hundred fifty-two pages are devoted to them, 315 of which are needed to cover the subject of capillary chemistry. The allotment of so much space to the latter is justified by "the fact that other expositions of this subject do not exist." For this section of the book alone, the whole book would be justified.

The following very condensed outline will show the scheme of Freundlich's treatment.

The physico-chemical foundations of colloid chemistry.

- Capillary chemistry.
  - Interfaces.
  - Capillary-electrical phenomena.
  - Properties of interfacial layers.
- Kinetics of the formation of a new phase.
- Brownian molecular movement.
- Colloidally disperse systems.
  - Colloidal solutions.
    - Sols—lyophobic and lyophilic.
    - Gels—lyophobic and lyophilic.
  - Mists and smokes.
  - Foams.
  - Solid colloids.

The order of arrangement of the second half of the book is chosen so as to bring more familiar systems to the attention first.

Again, Colloid and Capillary Chemistry is interesting. One might fear that, in a work of this magnitude, dreary tables, equations, and hypotheses would be the reader's reward. But Professor Freundlich has so interestingly interwoven these necessary and useful things with the things of everyday life, that it is difficult to leave off reading.

Colloid aud Capillary Chemistry is a veritable mine of information. The exceptionally large number of literature references further enhances its value. Twenty-nine pages of Addenda bring the book right up-to-date. The translation is excellent. Seven plates of photographs of X-ray diffraction patterns, ultramicroscopic objects, etc., of unusual clearness and beauty add to its interest. One hundred fifty-seven diagrams are used to assist the explanations. A comprehensive subject and author index rounds out this remarkable work. It is unfortunate that better paper and binding were not used, but these matters are not irremediable.

MALCOLM M. HARING

Kolloidforschung in Einzeldarstellungen. Vol. V. Das Polarisationsmikroskop.—Seine Anwendung in der Kolloidforschung und in der Färberei (The Polarization Microscope—Its Use in Colloid Research and in the Dyestuffs Industry), by HERMANN AMBRONN AND ALBERT FREY. Akademische Verlagsgesellschaft m. b. h., Leipzig, 1926. x + 194 pp. 14.5 × 22 cm. Paper, 12 Rm.; Board, 13.5 Rm.

The authors state in the preface that, according to the statement of a distinguished physicist, electricity is nothing else than the sum total of all the experiences which we have encountered and which we hope to still have in this life. The same may be said of light, and we can with good grounds make a similar statement for the structure of colloids. In order, however, to widen our experiences in all of the different possible directions, it is necessary to use very varied methods in our researches.

This book has as its primary object the task of pointing out a technic for the study of colloids which has in the past been but little used and which to all appearances can make many new and worthwhile contributions in this field. The methods are not new but have been long used and tested in the fields of applied and theoretical physics and in microscopical research.

The use of the polarization microscope in colloid research is not common as would be expected if one considers the importance of the contributions which it can make. The cause for this apparently does not lie in the lack of accuracy in the necessary apparatus, for such apparatus is readily available and can be easily

purchased for any large microscope. Neither is there lack in physical or crystallographic text-books of directions for studies employing polarized light. Such directions are, however, usually given from a theoretical point of view, and because of that have often produced the assumption on the part of the practical microscopist that he must first enter upon a series of mathematical and physical studies before he can begin his work with the polarization microscope. It is not to be derived that such studies should not be undertaken without a certain amount of knowledge of the polarization and interference of light but one can secure this in a very elementary way.

It is accordingly the purpose of this volume to present in a relatively simple manner the technic of the uses of the polarization microscope and its application in colloid research. It is the belief of the reviewer that the authors have done their task well. The first chapter (107 pp.) is devoted to technic, the second chapter (36 pp.) to double refraction in disperse systems, and the last chapter (27 pp.) to the optical methods for disclosing the submicroscopic structure of disperse systems. Such a book appears to be unique in chemical literature. From the standpoint of the reviewer, the most interesting parts are those portions dealing with the optical properties of biological materials, such as cellulose, gelatin, chitin, starch, muscle fibers, and nerve fibers, etc. The majority of the literature citations are to journals other than those regularly read by the chemist, but no one can glance through this volume without the feeling that the authors have succeeded in their object in placing in the hands of the colloid chemist and *the biologist* a new tool which can be profitably used to supplement those which are in common use at the present time.

The book is well printed on good paper and contains numerous tables and 49 figures including a color chart showing the Newton colors up to the eighth order, together with a number of other dispersion colors characteristic of double refraction between the limits $\nu = 0$ to $\nu = 2$. Both a subject and an author index are included.

ROSS AIKEN GORTNER

Hydrogen-Ion Concentration. Its significance in the biological sciences and methods for its determination. LEONOR MICHAELIS, M.D. Professor in the University of Berlin, Resident Lecturer in Research Medicine in the Johns Hopkins University. Volume I. Principles of the theory. Authorized translation from the second revised and enlarged German edition by William A. Perlzweig, M.A., Ph.D., Associate in Medicine and Chemist to the Medical Clinic in the Johns Hopkins University and Hospital. The Williams & Wilkins Co., Baltimore, 1926. xiv + 299 pp., including author and subject indices. 32 figures. 22.9 × 15.2 cm. $5.00.

In the preface to the first German edition of this book Professor Michaelis makes some caustic remarks upon the mistakes which have occurred because of failure to recognize the part which the hydrogen ion plays in several important equilibria. As Americans we are happy to remember a note which he published later calling the attention of his countrymen to American advances in this field and to the wide-spread acceptance here of those principles which he has done so much to establish. However, there remains a rather disconcerting aspect of the hydrogen-ion's popularity in America. All too often enthusiasm over a specific benefit of measurement and of control has not been the occasion for the pursuit of the complete story in which the hydrogen ion is found to have a part. We, therefore, welcome this translation of the second German edition of "Die Wasserstoffionenkonzentration" which outlines more extensively than the first the theoretical significance of hydrion concentration. With its aid investigators will more easily pursue the really difficult problems lying

behind the valuable but often superficial observations on the effects of changes in hydrion concentration.

In Part 1 there are described the classical equations for equilibria in systems of acids, bases, ampholytes, and their salts with some original developments. The second part deals with potential differences—not only those at the interface between solutions and electrodes (as the term electrode is usually employed) but also those occurring at the interfaces between phases (which may be included in Faraday's definition of electrode). Several aspects of the latter subject are not easily available elsewhere.

The book is not a text-book. It has that most valuable of all forms of scientific writing—the monograph form, wherein the perspective not found in original papers can be developed and the total experience of the expert can be felt. Both of these expectations are met in the present instance. Because they are met well and because of the subject-matter, the book is an admirable one to place in the hands of advanced students; but because the original text was written in 1922, the teacher will have to add supplementary notes.

In the main the translation is well done. The occasional clumsy expression seems to be due to an effort to render a faithful translation. The occasional little slip occurs and there is the occasional typographical error. None discovered by the reviewer is serious.

As usual the publishers have made a very presentable book but they have chosen a paper of such thickness that the 299 pages loom larger than seems justified.

W. MANSFIELD CLARK

Smith's Inorganic Chemistry. Revised and rewritten. JAMES KENDALL, Professor of Chemistry, New York University. The Century Co., New York, 1926. xxv + 1030 pp., 19 illustrations, 234 figs. 14 × 20.5 cm. $4.00.

"Every effort has been made in the rewriting of this book," says the author in his preface, "to leave the volume a characteristic Smith text." One familiar with the Smith chemistries will recognize much of his style and method of presentation in this new edition. While the author has injected a considerable amount of new material and has changed the order of presentation in a few places, the book in the main retains the original characteristics and method of developing the subject. It is replete with information presented in an orderly manner. The theoretical subjects are treated quite fully and explanations are given with a clearness that should enable the student to obtain a good understanding of the fundamental principles underlying the science of chemistry.

At the beginning of the book is given a list of the illustrations with a paragraph in explanation of each. This adds much to their value and should create a greater interest in them. Another feature which should be of considerable value to the student is found in the numerous sections throughout the text headed "A warning." In these he is warned against common but incorrect ideas concerning the subject under discussion.

A very interesting and full discussion of the atomic theory and crystal structure is given in the early part of the book. This is followed considerably later by a discussion of the Lewis-Langmuir and Bohr theories of atomic structure. The subject of valence, however, is taken up from the older standpoint in which the student so often gets the impression that valence is an abstract something that gives an element a capacity to hold other elements but is at a loss to know what that something is. It is regrettable that so simple and concrete a means, as is now available with our knowledge of the relation of the electron to the atom, should not be employed to explain this most difficult concept for the beginning student.

The author's treatment of carbon and its compounds differs somewhat from the usual method in that it is divided into a

number of chapters, each following the discussion of metals that have a commercial or scientific connection with particular classes of organic compounds, *e. g.*, in four chapters following the alkali earths, plant and animal life and their products are discussed, likewise following a chapter on aluminum is a discussion of synthetic organic dyestuffs.

The book is well written and the subject-matter is clearly presented, though it is probably too advanced and too voluminous for a first year's course unless more than the usually alloted time for such a course can be given.

GEO. W. SEARS

Excited Atoms Emit Electrons. An atom, if it gets sufficiently excited, may radiate electrons instead of energy quanta. This is one of the European advances in physics reported at Harvard University by Profs. P. W. Bridgman and William Duane who have lately returned from abroad.

Both professors expressed themselves as much impressed by the great activity shown among European scientists in all countries.

In order to study the magnetic properties of iron, single crystals of iron have been made about eight inches long by one-half inch thick. These crystals show no magnetic hysteresis at all and have other remarkable properties. In England Dr. Kapitza has developed a machine for producing the most intense magnetic fields ever attained. The field, which lasts only for one one-hundred-thousandth of a second, is produced by suddenly short circuiting a dynamo. The experiment is over before the mechanical shock, which is like an explosion, can travel from the dynamo across the room to the place where the field is produced.—*Science Service*

Wants Glass Industry to Be Artistic. The American glass industry has increased many fold in the value of its output and the amount of capital invested, and has developed many new ways of making modern types of glass apparatus on the market. Art, however, should not be left out, in the opinion of Prof. Alexander Silverman of the University of Pittsburgh, who described the history of fifty years of glass making to the scientists at the meeting of the American Chemical Society in Philadelphia. The plate glass of shop windows is now made by a new continuous rolling process, Prof. Alexander said, and bottles and electrical bulbs are made by machine. Much study has been devoted to the making of bullet-proof glass. New colors are being produced by the chemical element selenium and other materials in glass tableware.—*Science Service*

Unique Technic Used in New Typhoid Vaccination. A new method of inoculation against diseases of types represented by typhoid fever and Asiatic cholera is claimed by the Pasteur Institute. Its technic is based on the principle that since the small intestine is the organ chiefly affected in such diseases, the preventive vaccine should be able to do most good if introduced into its membranes directly.

Acting upon this idea, Dr. A. Besredka has given laboratory rabbits preliminary doses of beef bile by mouth, that have the effect of rendering the cells of the inner lining of the intestine temporarily permeable. The vaccine chaser of killed typhoid germs that is administered afterwards is then absorbed directly into these cells and produces a temporary immunity, he declares. Such immunity in human beings lasts about a year, it is stated.

Dr. Besredka reports that this sort of vaccination has been used successfully in dysentery epidemics in India and was found helpful in stemming a typhoid outbreak in Russia, during the past year.—*Science Service*

A FEW MINUTES WITH THE BUSINESS MANAGER

GRATEFUL STUDENTS

Those boys and girls who are successful in winning the yearly prize essay contests are grateful to the thoughtful instructors whose foresight leads them to interest their students in America's most important contest.

Local recognition, statewide honor or national fame may come to some boy or girl in your class. Whether it does or not, it is to your everlasting honor and credit to have your students see just a little bit more of the vast importance of chemistry to our every-day life and health. It will make them better citizens and they will look back in years to come to the wonderful leadership which you exerted.

Perhaps the winner will be a young person who could not otherwise pursue a university course. Yes—he will be grateful to you.

Students depend upon you to tell them of opportunities. Do not fail them—tell them of, help them with

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A Merry, Merry Christmas!

The Business Manager extends to you the greatest of all salutations—*A Merry Christmas.*

Through this year now drawing to a close, many of our readers have taken occasion to write us telling how they appreciated the articles, the editorials and the high-class advertisements which are brought to them twelve times a year. Further, many valuable suggestions have been sent to us. It seems as though we have been receiving Christmas presents throughout the year.

It is our only hope that we may continue to merit our readers' approval in the same unstinted way during the year which is about to dawn.

May Santa Claus be good to you!

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